The Engineer

LONDON, FRIDAY, MARCH 7, 1941.

PUBLIC NOTICES

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POWER DEPARTMENT

Applications are Invited for the POSITION of SHIFT CHARGE ENGINEER in the Company's Power Stations.

The duties will comprise the management of a shift operating modern power station equipment, including high-pressure water-tube boilers, turbo-alternators, E.H.T. switchgear, &c., and applicants, who should be not less than 33 years of age, must have had several years' responsible experience in such work, following a sound practical and technical training in mechanical and electrical engineering.

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Applications, giving age and full particulars of education, engineering training and power station experience, should be addressed to I.C.I. (GENERAL CHEMICALS), Ltd., POWER DEPARTMENT, c/o CASTNER-KELLNER WORKS, WESTON POINT, RUNCORN, CHESHIRE, marked "S.C.E." 7182

CITY OF MANCHESTER

ELECTRICITY DEPARTMENT

STEAM ENGINEER

Applications are Invited for the POSITION of SHIFT STEAM ENGINEER, to Take Charge of Shift in the Boiler-house of the Barton Power Station. He would be directly responsible to the Engineer-in-Charge of the shift.

The applicant must have had a mechanical training with a good knowledge of the operation of modern boilers of high evaporative capacity. Electrical engineering experience would be an advantage, although not a necessity.

Remuneration would be in accordance with K.9 of the National Joint Board Schedule of Salaries, with a commencing salary, at the present cost-of-living figure, of £374 per annum.

Applications, giving full particulars of technical training, previous experience, and age, together with copies of recent testimonials, must be endorsed "Shift Steam Engineer," and addressed to the Chairman, Electricity Committee, Town Hall, Manchester, 2, to arrive at these offices not later than Saturday, 15th March, 1941.

R. H. ADCOCK,
Town Clerk.

Town Hall,
Manchester, 2.
1st March, 1941. 7187

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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1940 No. 877
RESTRICTION ON ENGAGEMENT ORDER

A LARGE Continuous Process RAYON FACTORY REQUIRES the SERVICES of a fully qualified ELECTRICAL ENGINEER for Control and Maintenance of the Factory Electrical Equipment. Applicants must be capable of initiating and drawing up plans and specifications for any additional plant which may be required. The present equipment comprises extensive E.H.T., Med. T. and L.T. networks, including turbo and motor generators and a large number of heavy and small power drives. Applicants should be capable of controlling a staff of shift and daywork electricians engaged on installation and running maintenance work.

Applications should state age, qualifications and previous position held. Salary £450 p.a.
Address, 7190, The Engineer Office. 7190 A

APPLICATIONS are INVITED for the POSITION of BOILER-HOUSE OPERATING ENGINEER on shift duty at a Power Station near London. Applicants must have served an apprenticeship in mechanical engineering and previous experience and responsibility for the operation of boilers in a power station will be an advantage. The commencing salary is £375 p.a. plus a war bonus. Applications in writing, giving age and full particulars of education, training and experience must be sent.—Address, 7189, The Engineer Office. 7189 A

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The Engineer

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It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

SITUATIONS OPEN

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, April 25th.

ADVERTISEMENTS

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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123 ft.	36·3	×	29·4 mm.	1·429″	×	1·157″
3090 ft.	40·3	×	31·2 mm.	1·586″	×	1·228″
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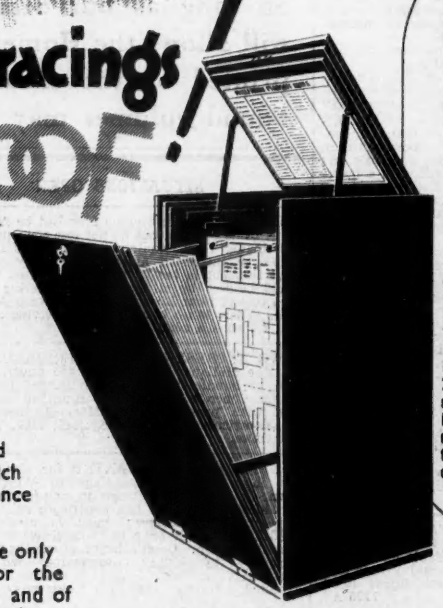

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The Ministry of Works and Buildings

IN the course of a speech made in the House of Lords on Wednesday, February 26th, Lord Reith, the Minister of Works and Buildings, outlined the scope of the work of his Department, which, he said, had been charged with the special responsibility of seeing that all practicable preparations are made for the physical reconstruction of town and country. While many of the matters to be taken into account concerned other Departments, his particular responsibility, Lord Reith said, was to exercise the functions of central planning and co-ordination, and to initiate the work and give general guidance and supervision. By arrangement with colleagues, he proposed to utilise the resources of other Departments, and to ask for the collaboration of professional and technical associations. Lord Reith said that he was now selecting a small staff, with the necessary knowledge, to work with him at the centre. Further, he was inviting a dozen or twenty individuals who had had special experience in this field to assist him and to be associated with the work from the beginning in a consultative capacity. The first step was a thorough examination of the various points of view, profiting from the past, and in due course there would be policy decisions on such questions as the place of agriculture in the national economy, the distribution of industry, and the organisation of transport, which would be applied by planning. Immediate work included measures to prevent action during the war which would prejudice the work of reconstruction after it, and the examination of actual conditions in what might be regarded as test areas. For a basis of this inquiry three heavily damaged areas—Birmingham, Coventry, and Bristol—had been chosen. Alongside the work of reconstruction outlined by Lord Reith, and with his support, the National Buildings Record has been formed under the direction of an Advisory Council, with offices at 66, Portland Place, London, W.1. It will form a centre for making, collating, and indexing records of notable buildings of all kinds.

The Manchester Ship Canal Company

THE annual meeting of the Manchester Ship Canal Company took place on Friday, February 28th, the chair being taken by Sir Frederick J. West. New members of the board include Dr. C. J. T. Cronshaw, D.Sc., F.I.C., chairman of the Dyestuffs Group of Imperial Chemical Industries; and Councillor Colonel S. P. Dawson and Councillor Samuel Meadowcroft, representing the Manchester Corporation. The net revenue for the year was £869,462. Adding to that sum the balance brought forward of £23,467 and deducting provision for taxation £245,000, loan interest £374,243, and an appropriation to reserve for contingencies and repairs, leaves a balance of £238,686 for dividends, out of which £25,269 is carried forward to next year's account. The expenditure on the Ship Canal, the Bridgewater Canal and on railways totals £1,326,670, which is less than it would have been had the company been able to effect renewals and carry out repairs on the basis of a normal year. In order that the accounts should not show a false position in this respect, and to enable the carrying out of the necessary work at a future date without burdening that period with the cost, the sum of £125,000 has been set aside under the heading of deferred maintenance. Certain amounts have also been provided for the renewal of working plant, such as craft, cranes and rolling stock.

The Chamber of Shipping

AT the annual general meeting of the Chamber of Shipping of the United Kingdom, which was held in London on Thursday, February 27th, Lord Rotherwick was elected President of the Chamber for the ensuing year, and Mr. Philip Runciman Vice-President. In his Presidential Address, Lord Rotherwick said we could continue to feel every confidence in the ability of the Royal Navy and the Royal Air Force to retain the mastery of the seas. We must, he said, strive unremittingly to improve the protection of our merchant shipping. It was important to ensure that we were not using fast ships on less dangerous services which could be performed by slow ships; with fast ships it was possible to reduce the time each had to spend in passing through the danger areas, thereby reducing the ratio of risk to cargo imported or exported. The shipbuilding policy of the Government so far adopted during the war was, he felt, open to criticism. In order to produce the maximum volume of new tonnage the Government had concentrated on large numbers of ships of the "box" type, with slow speeds of between 7 to 8 knots. It was only now, after eighteen months of war, that the Government had turned its attention to faster cargo liners with a speed of from 16 to 17 knots. Such fast ships were being built for shipping companies at the outbreak of war, and the owners were prepared to continue the construction of them on their own account. Under the Government programme, however, all yards were taken up with the building of naval craft or slower ships. Lord Rotherwick expressed the view that it would have been a wise policy to have reserved a larger proportion of the shipyards for the construction of fast ships to private account. If that had been done, a considerable volume of fast tonnage would now be at the owners' disposal and there would be less call on our destroyers. In moving a resolution urging the Government to maintain the British shipping industry, both in war and in peace, Lord Essendon said that from the point of view of the time factor, the repair of ships was more important than the completion of new ships. He advocated a separate department for the repair of shipping, a step which was taken in the last war.

Dock Labour in Merseyside, Manchester and Preston Areas

IN a leaflet issued on Thursday, February 27th, the Minister of Transport explains the Government's proposals for employing all the dock workers registered at Liverpool (including Birkenhead), Manchester, Preston, Garston, Bromborough, Ellesmere Port, Partington, Widnes, Runcorn and Weston Point on a guaranteed (weekly) basis, combined, when possible, with payment by results. The scheme will come into operation at each port at the beginning of the pay week which commences next after March 10th, 1941, and opportunity to enter the scheme will be afforded to all men registered at those ports who were available for dock employment during the week ending March 7th, and to any other dock workers whom the Minister may subsequently take into employment. Any man who accepts employment will be required to present himself for any employment at any of the ports for a minimum of eleven turns each week. Each man will be paid the full amount of his earnings, and will be guaranteed payment for the eleven turns. The men will be employed and paid by the Minister of Transport, who will operate the scheme through the Regional Port Director. From the labour force so made available the Labour Superintendent, on behalf of the Regional Port Director, will allocate to "approved employers," such as master stevedores, master porters, &c., numbers and types of men to meet their requirements. The scheme which has been worked out in agreement with the employers and the Transport and General Workers' Union is a wartime measure to secure the quicker turn round of ships in port. Copies of the leaflet are obtainable from H.M. Stationery Office, price 2d. each.

Labour in Shipyards

As a further means of speeding up the output in the shipbuilding and ship repairing industries the Minister of Labour and National Service has taken action under the Industrial Registration (No. 1) Order to bring back into these industries many of the men who left them in the years of depression. Any man who at any time during the last fifteen years has been engaged for not less than twelve months in any occupation connected with the shipbuilding and ship repairing industries is required to attend at a local office of the Ministry of Labour and register particulars of himself. The Order applies to any man aged twenty or over who is capable of work. The only exception to this rule are men who on February 24th were employed in an undertaking which is engaged in shipbuilding or ship repairing, including marine engineering, where this is carried on in a shipyard or a ship repairing establishment. Men are required to register between Monday, March 17th, and Wednesday, March 19th, and the local offices of the Ministry will be open from 9 a.m. to 4 p.m. Should any man be prevented from attending the office of the Ministry between these hours, owing to the times during which he is at work, he can register by obtaining Form E.D. 251 from a local office and returning it on completion to the local office not later than Saturday, March 22nd. The same method may be adopted should a man be living more than 6 miles from the local office or should he be unable to attend owing to sickness. Men to whom the Order applies should register, even though they may have registered in August of last year under the previous Industrial Registration Order.

Closing Redundant Factories

IN a statement made in the House of Commons on Tuesday, March 4th, Captain Oliver Lyttelton, the President of the Board of Trade, outlined the policy of the Government with regard to the concentration of production. He said that the aim of the Government's economic policy in wartime was to facilitate the fullest possible transfer of resources to war production. This policy demanded the severe cutting down of civil consumption and the release of labour, materials, and factory space for more essential purposes. Substantial cuts had already been made, and those might well have to be extended. In particular the Government was concerned with the group of industries manufacturing consumer goods affected by the Limitation of Supplies Orders or by the rationing of raw materials—hosiery, pottery, the major textile industries, boots and shoes, and some others. Those industries provided the main sources of factory-trained labour for munitions, and their consumption of imported materials must be kept down to the minimum required to meet essential needs. It was proposed to concentrate production in a reduced number of factories working full time, which would serve the output required for Government orders, the greatest practicable export trade, and the minimum needs of our population, while at the same time preserving the goodwill of the factories closed down. Discussion between the Board of Trade, in association with the Ministry of Labour, would be opened as soon as possible with representatives of employers and workers in the industries concerned. The scope of the Export Council is being expanded, and it is to be renamed the Export and Industrial Council. An executive organisation under a Controller-General of Factory and Warehouse Accommodation was being established.

The Future of Transport

IN the Keith Lecture, recently delivered before the Royal Scottish Society of Arts by Mr. George Mills, the Divisional General Manager of the London and North-Eastern Railway, Edinburgh, the lecturer dealt with the future of transport, and the new factors which will have to be faced when planning the transport of the future. Dealing with the relation between road and rail transport, Mr. Mills reminded his hearers that the railways of this country to-day comprise four main groups, all of which are privately owned, but are regulated as to safety in operation, wages scales and goods rate by Government Department or Tribunal. The road hauliers number about 60,000. They have some measure of common agreement, but do not speak definitely with one voice. In contradistinction to the railway, the road haulier is individualistic in outlook with an entirely natural bias in favour of conveying only that which will pay him best. The railway company, however, is bound to accept whatever is offered. It was in the national interest, said Mr. Mills, that these two diametrically opposed conceptions should be brought into harmony. With regard to railway nationalisation proposals, it should always be borne in mind that there were really no examples of nationalised railways which paid their way. British railways, Mr. Mills said, had at least paid their way, and although much of their capital had received no dividend, and such dividends as had been paid were modest, no British railway had been a burden to the State. Discussing the possibility of closer working between rail and road interests, Mr. Mills suggested that a pre-requisite was the sensible decentralisation of transport work into areas, one such area being Scotland. It could not be emphasised too often, concluded Mr. Mills, that national transport did not consist of carrying 2 tons of pre-selected beautifully packed commodities in a 2-ton lorry, with a certainty of a return load, but in handling all the commerce of the nation, whether it consisted of 10 cwt. of empty crates or 10 tons of iron ore, between the hamlets as well as the industrial centres. The future system of transport, he held, must bring within its ambit both road and rail transport, and be really national in character.

Manchester's Road Problems

IN a report of the Manchester Corporation Highways Committee, which was presented at the City Council in Manchester on Wednesday, March 5th, concern is expressed at the unsatisfactory state of the roads in the city. It is estimated that a sum of more than £1,250,000 is now needed in order to carry out the work of reconstruction and repair. Against that amount the Committee points out in its report that only under strong pressure has it approved the very inadequate figure of £205,312. This matter has been brought before the Council by the Committee on more than one occasion, and it is pointed out that for the period 1932 to 1936 the amount considered essential for maintenance was reduced by £389,194. It had been hoped by the Committee that in the next five years it might have been possible for the Council to overtake some of these arrears, but again its estimates were reduced and further arrears have accumulated. The Committee now estimate that to put into proper repair roads in the city, where reconstruction is considered necessary, and to carry out repairs to roads where reconstruction is not needed, would at the present time cost £1,330,000. Considerable damage was caused last winter by excessive frost and snow and wear and tear from traffic. At the present time it is stated that there is an accumulation of approximately 12,000 square yards of reinstatement work after disturbance by other departments, and in addition 6500 square yards of carriageway and 28,500 square yards of footpath damages by enemy action have to be dealt with. Finally, about 150 miles of abandoned tramway tracks will have to be removed and the roadways reconstructed. So far only 21 miles have been dealt with.

The Hong Kong Centenary and Applied Science

By Dr. C. A. MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. V

(*Continued from page 142, February 28th*)

Problems of Water Supply

THE Waterworks Construction Department has had in recent years the record for expenditure of Government funds, but the money has been well spent for the benefit of the community. It seems certain that a good deal more will have to be spent on waterworks construction at no very distant date.

The Chinese words "Hong Kong" are translated as "Fragrant Streams" or "Sweet Waters." An English visitor to the island from one of the ships in 1842 wrote: "The lake-like appearance of the harbour is beautiful; it forms a sort of basin, lying between the mountains of Hong Kong and the mountains of the mainland opposite. For this reason, however, the rains are sometimes excessively heavy; the dark threatening clouds seem banded across from one side to the other, pouring down their waters in torrents upon the basin between them. The mountain sides of Hong Kong, steep though they are, occasionally appear almost covered with a sheet of moving water, so torrent-like do the streams pour down the declivities." That was in the summer, the rainy season, probably after a typhoon had just missed the Colony. The waters nowadays come down in torrents, swirling down the nullahs built of granite, bringing silt from the hillsides; the barren soil of decomposed granite which is deposited in the harbour; it makes the dredging of the fairway imperative.

The island gained a reputation for its "sweet waters" at least twenty years before it was a colony, as British ships took water supplies from it. In the early years of the Colony the streams and a few wells satisfied the local demand; probably enteric diseases were caused by contamination from human excreta, but no one thought of that until many years later.

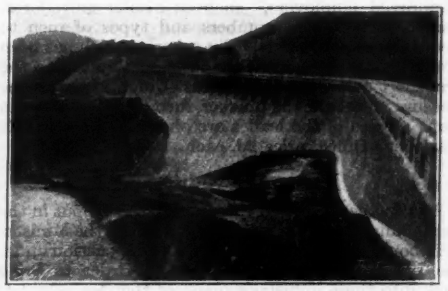
After a few years, however, there began an agitation for a more reliable supply of water. There were lengthy discussions between Government officials and the commercial community on this subject. The parties seem to have often been at loggerheads about many local problems, and no doubt personal likes and dislikes helped to prevent agreement. The Government said that the commercial community ought to form a company to supply water, but no doubt the merchants thought that their money would gain bigger profits in trade. It was fortunate for the Colony that they refused to undertake the work, for at some time later the Government would have been compelled to take over the supply, and the original shares would have increased very much in value, as has been the case with all public utilities in the Colony financed by private enterprise. However, finally the Government decided to act, but the consent of the Colonial Office in London had to be obtained.

In the 1857 annual dispatch to the British Colonial Secretary, the Governor wrote as follows: —"We have now a permanent town population of nearly 40,000 souls entirely dependent on a few mountain streams." He urged that the Government should undertake a public supply which he estimated would cost £20,000. Since that date millions of pounds sterling have been spent on water supply—it is difficult even to make a rough estimate, but the Shing Mun dam alone cost about one million. It is my own belief that millions more will be spent on water supply soon after peace returns.

Although the relations between Government officials and the rest of the local community are very much better than in the early days of the Colony, yet the merchants and the newspapers do not hesitate to criticise and to complain about the neglect of their interests. No local subject has excited so much criticism, at times angry and usually justified, of the local government as this matter of water supply. During my residence in the Colony (1912–39) there were frequent restrictions, great inconvenience being caused when all supply was cut off each day (for months) and for long periods during the twenty-four hours, simply because the Government administrative officials would not take the advice of local engineers and prepare increased water storage. The supply was often entirely cut off from Chinese tenement houses, where the bulk of the population lives. It was no uncommon sight to see long lines of poor and patient Chinese waiting for hours with buckets to take their turn at a public standpipe. The people of almost any other race would have caused riots. One year the water famine was so bad that ships were chartered to bring water from up the coast, and brick tanks were built on the praya, from which the water was doled out. This water shortage was so unnecessary that small wonder there was great indignation about it. We all knew that engineers had warned and warned the Government that there would be a water famine unless more storage was provided. No one had, or has, a greater pride than the writer in the story of the British record in Hong Kong; perhaps few residents would confess to the same admiration for the local government administrative officials as a whole, as it often seemed to me only fair to do; but when the short-sighted officials refused to take notice of the warnings of experienced engineers concerning water shortage, then it was impossible to attempt any defence of their conduct.

The Abnormal Rainfalls

As long ago as 1892 Sir Alexander Binnie read a paper before the Institution of Civil Engineers, entitled "On Mean or Average Annual Rainfall and the Fluctuations to which it is Subject." It is generally believed that there is such a thing as a



TYTAM TUK DAM

rainfall cycle, with a period of roughly thirty-three to thirty-six years; and it was on the assumption —subsequently confirmed in this particular case— that the cycle would include a period of low rainfall that the Hong Kong engineers based some of their pleas for more storage.

When we consider the variety of conditions that influence the rainfall in different parts of the globe, it is remarkable that the rainfall figures for any locality—except any exceptionally dry one—conform to certain laws. It is, for example, curious that although typhoons strike Hong Kong at most irregular intervals (sometimes two or three a year and then some years none), yet rainfall in the Colony has a close relationship, in regard to extremes and fluctuations, to those of India and countries in Europe, in spite of the fact that typhoons are invariably accompanied by very heavy rainfalls.

My colleague, Professor F. A. Redmond, has pointed out that for the period 1884–1939, the wettest year in Great Britain, France, North Germany, Russia, India, and Hong Kong was 1889, and that in all these countries the driest year was 1895.

The records from the Royal Observatory, Hong Kong, for the period 1884–1939 give an average rainfall of 85·12in. For 1930 the figure was 96·08in., and for 1938 it was 55·36in. For the period 1918–27 the average fall was 95·39in. Those were the wettest ten years on record. For the period 1929–38 the average fall was 77·67in.; this was the second driest ten-year period on record.

The minimum rainfall recorded for any one year was 46in. in 1895. The general average, as recorded at the Royal Observatory, is 90in. per annum, but that figure is higher in some places in the Colony.

On July 19th, 1926, there was recorded in Hong Kong a rainfall of 3·965in. in one hour! In one month (May, 1889) the record was 48·84in.

In May, 1889, during thirty-six hours, there fell some 38in. of rain. The official report states:— "The effect upon a place situated as is Victoria [City] on the lower slopes of a ridge of high hills may be easily imagined. Landslips caused the discharge of many thousands of tons of loosened stones and earth upon the lower levels, uprooting trees, filling reservoirs, blocking and bursting sewers, and raising some of the waterside streets from 6ft. to 10ft. above their natural level. In one place a strong stone and brick sewer was burst, and the 19ft. deep earth above it was carried away, leaving a gap 300 square yards in extent, and huge granite boulders, descending from the heights, destroyed in three places the solidly built cut stone conduit of the Tytam waterworks. . . . Some few lives were lost. . . . and it is a matter of wonder that the number was not much larger; indeed, when it is calculated how many millions of tons of water fell on the steep incline above the town, it is a matter of congratulation, and speaks well for the general solidity of work, that there was not a far greater aggregate of destruction."

During my residence in the Colony a large boulder of granite, calculated to weigh about 1000 tons, was loosened by heavy rainfall and rolled down the hillside on to a large pumping station. The building and the machinery inside were wrecked, and four men inside the building were killed. It was fortunate that the wide flat level ground whereon the pumping station stood received the boulder and stopped further progress, otherwise its path down the hillside to the sea—a drop of some 200ft.—would have been through crowded tenement houses.

Enough has been written to show that rainfall in the Colony causes the Public Works Department engineers considerable anxieties for two reasons. The torrential rains during the summer months often cause devastation; the long dry seasons in winter, when there is little or no rainfall, makes imperative very large storage reservoirs, catchment areas, &c. During many years the storage was very inadequate.

Figures of rainfall in different parts of China are of immense value because of the terrible floods that have taken place, and are likely to occur in that country until scientific records and engineering works are maintained. The example of Hong Kong has stimulated interest in China in this important subject of rainfall records.

The Need for Storage Reservoirs

At the present time the storage capacity of all the reservoirs on the island and the mainland totals about 6000 million gallons, and plans have been made to increase it. The great problem has been to find suitable sites for reservoirs. Practically all of the water supply is from rainfall collected from reserved catchment areas. The "fragrant streams" are trained along nullahs in many places, although some, remote from dwellings, still retain their more natural and beautiful setting where mosquitoes breed. On the island about one-third of the land area has been reserved for catchments; much larger areas are reserved for this purpose in the leased territory.

Great care must be taken to prevent contamination. There was a bad outbreak of typhoid in 1924, resulting in several deaths amongst Europeans. This was generally believed to be due to the contamination of the Pokfulam reservoir. A new road was being made and coolies who walked over the catchment showed no regard for sanitary precautions. Chlorine was supposed to be placed in the reservoir daily, but it is assumed that this was not done for a few days. More scientific methods of chlorination are now in use, and it is noticeable that mechanical filters are rapidly replacing the old static sand filter beds.

After a great deal of controversy, at last the work for the first reservoir (at Pokfulam) was put in hand. A small intake reservoir holding 2,000,000 gallons only, and a 10in. cast iron main to Victoria were completed in 1863; extensions to provide storage for 66 million gallons were arranged, as the demand for water was much in excess of the supply in the winter months. But this scheme raised the ire of a Governor, who arrived after the work had commenced. He made some scathing comments on the local Public Works Department engineers in a dispatch to the Secretary of State for the Colonies. It was written in 1869, when Governors did not worry about what the governed had to say. And although, from the earliest days, there have been some splendid Governors in Hong Kong, this dispatch-writer of 1869 seems to have left the reputation of being of the Colonel Blimp type. This is the sort of stuff he wrote: "You

will observe that out of 137,000 dollars, estimated for works and buildings, no less than 98,000 dollars are required for completion of the reservoir at Pokfoolum. The original estimate for that work, by which the Government was induced to undertake it at all, was 100,000 dollars, whereas it now appears that it will cost double, whilst, as it is half completed, you have no option but to proceed with the work. Its whole history, however, has been most discouraging, as showing how heavily, even when attempting the most useful and necessary objects, the Colony can lose by the occasional incompetence of its employees, and how seldom the most obvious deficiencies of such persons can restrain them from projecting schemes beyond their strength. I only regret that the work had been proposed and launched before my arrival here. It is true that suggestions by an eminent engineer in England have added to the cost of the work whilst in progress. Those suggestions, however, were few, as, indeed, the most eminent professional man could suggest little as to a scheme whose general propriety and fitness depended on circumstances not before him. The most costly change was the substitution of cement for ordinary mortar, and if the change was essential, I see no reason why that point should have escaped attention here."

Thus, nearly thirty years after the Colony was founded, and when the population was about 140,000, the inhabitants on the island were still almost entirely "dependent on a few mountain streams" for their water supply. It is obvious, however, that when the supply from the first reservoir became available the advantages of the new system were soon appreciated. There is a large area of land at the east portion of the island, known as the Tytam district, and a series of reservoirs from the gap over the hill to the sea level was ultimately built. The last of the series (the Tytam Tuk reservoir) was completed in 1917. The storage capacity of this reservoir is 1420 million gallons.

The Tytam scheme was recommended by Sir Robert Rawlinson, who investigated the problem of water supply for the Hong Kong Government. The first section of the whole of the works was carried out during the years 1883 to 1889. It cost just over 1¼ million dollars. It relieved the situation for a time, as it brought the total storage capacity up to 378 million gallons.

No further storage works were undertaken until 1899, when the completion of the Wongneicheong reservoir brought the available storage capacity up to 510,660,000 gallons. Then came the great water famine of 1901, when water was imported to the island by boat, and police and troops regulated the long queues of water carriers waiting on the water front. The Tytam Bywash reservoir (storage capacity about 26¼ million gallons) was completed in 1904, and the Intermediate reservoir in 1907. This latter involved pumping machinery to force the water up to the inlet of the Tytam tunnel. This brought the total storage capacity for the island up to just over 747¼ million gallons.

"The Able and Indefatigable Surveyor-General"

It is pleasant to be able to record the appreciation of a Governor, who in 1888 addressed to the Secretary of State for the Colonies a dispatch concerning this vexed question of water supply. Although this proves, again, a lamentable lack of foresight, yet it does show that the administration realised that the life of a Government engineer in Hong Kong, like that of W. S. Gilbert's policeman, was "not a happy one." He refers to the "Tytam Waterworks" (and the admirable Surveyor-General), as follows:—"This great enterprise (which comprises the confinement of 350 millions of gallons of water by a dam constructed of granite and concrete at a distance of 5 miles from the City of Victoria, and the conveyance of the supply by means of a tunnel, 2450 yards in length, and a cut granite aqueduct for the remaining distance) was so far completed that the water was let into the existing 'mains' in October, 1888." The Governor, however, "regrets that this magnificent supply of water is, and for some time to come must remain, comparatively unavailable," because provision had not been made earlier for its distribution. He states: "The delay in this and various other even more needed public works must be chiefly attributed to the undue weakness of the staff of the Surveyor-General's Department. The extraordinary density of the population, living for the most part on or under the abrupt slopes of a hill, 1100ft. to 1800ft. in height, together with the comparatively recent and very rapidly increasing settlement of Europeans on and in the neighbourhood of the summit, requires from this Department, in the interests of public health and safety, a far closer supervision of private works than is ordinarily necessary elsewhere, and imposes duties which are probably more in number and far heavier in degree than are required from any similar area or population in the world."

He explains that the staff of the Public Works Department must be increased and the work reorganised.

Then follows a tribute to a Government engineer, so rare in the annals of the Colony that it startled me when it was discovered after many years of delving into the history of Hong Kong. The Governor of 1888 wrote: "The health of the able and indefatigable Surveyor-General, Mr. Price, who has just retired from the service, gradually succumbed and eventually broke down completely in the endeavour, naturally but very imperfectly successful, to do the work of several ordinary men."

Those words reminded me of the fate of another Government engineer in Hong Kong, many years later. His name was Jaffé. He designed and supervised the construction of the big dam for the Tytam Tuk reservoir, living for about five years in that locality, then notable for a bad type of malaria. Soon after the dam was finished Jaffé retired sick and died soon afterwards. There can be no doubt that his devotion to duty and his anxiety to save public funds shortened his life. Yet no special allowance was made to his dependants. They suffered because he would not give the time needed for social contacts, for he concentrated on his work. A few years later a popular merchant died, practically penniless. A subscription was made for the widow, and generous residents raised enough to purchase for her a house in England costing about £1700 and an annuity sufficient to maintain her in comfort. The residents of Hong Kong have a splendid record for generosity—but engineers are not generally prominent in public life.

It is of interest to note that Mr. R. M. Henderson, who recently retired from the office of Director of Public Works, arrived in the Colony in 1912, and his first appointment was that of assistant engineer under Mr. Jaffé, during the construction of the big dam at Tytam Tuk.

With the completion of the Tytam Tuk reservoir, the total storage capacity on the island reached about 2200 million gallons. When the big dam was finished and the reservoir officially opened, the following interesting statement was made in a local newspaper:—"The completion of this important scheme thus places the Colony for the first time since its foundation in the position of adequate storage to tide over years of insufficient rainfall. It may here be interposed that in the dry season of 1916 to 1917, had it not been for the advanced state of the Tytam Tuk reservoir and the new pumping plant, Hong Kong would have been, as far as the supply of water is concerned, on very short commons."

There was also the statement: "The contents of the Tytam Tuk reservoir will alone be sufficient to maintain the present requirements of full supply for a period of 236 days." When the Governor of the Colony opened the reservoir he was sanguine that there would be no more worries about water shortage. But the demand for water increased so much that by 1920 the Public Works Department engineers were urging that more storage should be provided.

Meantime, a reservoir had been built in the leased territory, not far from Kowloon City, in order to supply by gravity that rapidly growing centre. Mr. Henderson was in charge of the Water Department, Public Works Department, and in 1921 began to urge that storage should be provided at Shing Mun in the leased territory. He prepared detailed plans to utilise the large catchment area around the Shing Mun valley, but he received very little encouragement from the Governors in the decade 1920–30. Then came another water famine as a result of the delay in building storage at Shing Mun. Once again ships brought water to the Colony, and patient Chinese waited for hours to obtain their ration of water. For the more wealthy members of the community there were rigid restrictions; water supply was cut off from houses except for short periods during the twenty-four hours.

The Shing Mun Scheme

From the above it will be realised that for about the first thirty years of the history of the Colony there was no public water supply from a reservoir. Then the small Pokfulum scheme came into operation, but this soon proved to be insufficient. There was an investigation by Sir Robert Rawlinson, who reported in favour of what is known as the Tytam scheme. The details concerning these reservoirs have been described in two contributions to the "Proceedings" of the Institution of Civil Engineers; it is only necessary to add that the belief expressed on more than one occasion that the construction of first one and then others of these reservoirs would be a final solution of the storage problem proved to be a fallacy. Two small reservoirs were made available near Aberdeen after the scheme for a reservoir at Shing Mun had been turned down—that was about 1930. Finally, the Shing Mun scheme, details of which had been worked out by Mr. Henderson when he was the Executive Engineer in charge of the Water Supply Department, was referred to the eminent consulting engineers in London, Messrs. Binnie, Deacon, and Gourley. They reported in favour of a big dam in the Shing Mun Valley, which they subsequently designed, and which was erected under their supervision.* The reservoir can hold 3000 million gallons, a capacity equal to that of all the other reservoirs in the Colony. Pipe lines across the harbour enable this water to be supplied to Hong Kong island.

It should be explained that for some years before the Shing Mun reservoir was built, water from the Shing Mun Valley had been carried some miles to the Kowloon reservoir and that pipe lines had been laid across the harbour to link up this supply with Hong Kong island. But the big problem is storage. Already there have been suggestions to increase the storage by building another reservoir in the leased territory, but it is unlikely that anything will be done until peace returns. When those happier days come, it is probable that there will be a big increase in the trade and population in the Colony and more water storage will be needed.

The Tytam reservoir was constructed during 1883–1889, the dam being built of masonry and concrete. There is available in Hong Kong an unlimited suppy of excellent granite, but the cement had to be brought out from England. The dam was considered a triumph in its day; all of the work on it was done by hand labour, bamboo scaffolding being used. Again, during the construction of the much larger dam at Tytam Tuk—1912 to 1917—there was no power and practically no mechanism used. The dam has a maximum height of 171ft. from the lowest part of the foundations to the road level. The maximum width at the base is 115ft. and the length of the dam is 1200ft. (excluding the tongues which extend into the hillside at each end of it). The roadway over the top, wide enough for two lines of motor traffic, is carried over the overflow sill on twelve arches, each of 20ft. span. A unique feature of the dam is that for a length of 238ft. the foundations on the sea inlet had to be carried 40ft. below the sea level. The original plan was to build the dam further towards the sea, but the size of the reservoir had to be curtailed as exploratory borings showed that the foundations there would be very unsatisfactory. The dam itself, from the foundations to the top level, is built entirely of cement concrete, the whole of which, with the exception of a layer adjoining the water face, has large granite stones embedded in it, while the layer in question is all of fine cement concrete. The cost of the dam, pumping plant, and mains to the upper reservoir was about 2½ million (local) dollars, at that time equivalent to about £260,000. At times, during construction, as many as 2000 men were at work on the dam. It was an amazing sight to watch the Chinese coolies hauling up huge granite boulders, slung on bamboo poles carried on their shoulders, from ground level to near the top of the dam, the front of which was covered with bamboo scaffolding; the boulders were embedded in the dam. The staff resided on site and malaria was a deadly enemy.

Malaria at Shing Mun was bad in the early days of the work. During the construction of the approach road the casualties amounted to 12 per cent. per day. But permanent concrete drains, totalling 22 miles in length, drained the 986 acres around the dam, and these drains, together with other measures, greatly reduced sickness due to malaria.

It will be remembered that this Shing Mun dam is 285ft. from the river bed to the crest, and is said to be the highest in the British Empire. It consists of four sections, viz., a water-tight face containing 9000 cubic yards of reinforced concrete, a thrust block of about 140,000 cubic yards of

* THE ENGINEER, January 22nd, 1937.

plain concrete, the rock fill amounting to about 700,000 tons in weight of granite blocks set by hand, and a sand wedge to give a certain amount of elasticity to the whole structure.

There is, for this reservoir, a smaller structure, the Pineapple Pass dam, 82ft. high, which originally had a sand wedge. It is worth noting that although the sand wedge in the big dam seems to have been a success that in the smaller dam did not prevent leakage from the reservoir, and some inconvenience was caused when it became necessary to replace the sand wedge with concrete as the full storage capacity of the reservoir was not available during this alteration.

About 2500 workmen, and a European staff, were housed on site. Food for the Chinese workmen was bought at wholesale rates in the Hong Kong markets, the allowance for each man being about 12s. worth of food per month. This 12s. per month for food was a much more generous diet than was general at that time for Hong Kong labour. The dam was built in an incredibly short period of about three years; this saving of time and money was very largely due to the amazing energy and organising ability of the resident engineer, Mr. Gifford Hull, M. Inst. C.E., who was responsible both to the Hong Kong Government and to the consulting engineers. Although the dam at Shing Mun was of at least three times the volume of the dam at Tytam Tuk, it was built in a much shorter time. A long working day was established, much work was done at night, and wherever possible modern mechanism was used. It was an excellent example that showed the advantages of using power even when cheap labour is available.

The absence of a supply of filtered water in Chinese towns and the crude arrangements for sanitation would make the European engineer who visited these towns and villages in China marvel that the inhabitants have managed to survive. There is the universal custom of tea drinking in China; it is probable that boiling the water for tea is a reason why the Chinese people have avoided the enteric diseases that afflict Europeans in China, unless they are very careful. But western-trained Chinese doctors and engineers advocate modern methods of water supply for Chinese towns, and in Hong Kong there is an example of what can be done to provide a supply of pure water for domestic purposes in China.

The work of the Waterworks Maintenance Department is perhaps not of such general interest as construction works, but it can be said that every effort has been made by the engineers responsible to keep the system up to date.

It has been impossible to include many interesting details of work done by the Public Works Department engineers. The object has been to sketch out the difficulties under which many of them have worked. The conditions of service have very much improved in the last decade, and the efforts made by the Government engineers are gradually becoming more appreciated by the rest of the community. But throughout the whole time of my residence in the Colony they had my sympathy and even now it seems to me hardly just that their salaries and status in official circles should be less than those of men of the same age who are in the administrative departments.

Commercial Engineering Works

In addition to the dockyards, there are many other mechanised industries. Mention has been made of the excellent cement produced in Hong Kong. There are a large number of weaving and knitting factories. In one year (1938) electric torches and batteries to the value of over £300,000 were made and exported, while canvas and rubber shoes made and exported were valued at over £400,000. There are factories making rope, glass, cigars, cigarettes, &c., with modern mechanism.

There are two electric supply companies, one for the island and one for the mainland. On my arrival in Hong Kong the supply was with 75 single-phase frequency; every motor had to be built especially for Hong Kong. The station was perched up on a ledge of rock about 300ft. above sea level, where extensions (badly needed) were almost impossible. Chater had sold the site to the first supply company—that was a condition of his support, according to local tradition. In an address delivered soon after my arrival in Hong Kong the opportunity was taken to mention that this power station was an excellent object-lesson to our engineering students to demonstrate how the general public suffered from out-of-date equipment. Then the fun began. The Governor demanded an explanation, Chater was furious, and even suggested that my criticism was prompted by the desire to be retained as a consultant. My retort to the Governor was that Messrs. Preece, Cardew and Snell should be requested to report, and ultimately this firm entirely reorganised the whole of the electric supply system for the island, to the great benefit, not only of the Colony, but of the shareholders of the company. A new and very efficient station on sea level was built, and from time to time extensions have been made. This firm of consulting engineers also carried out the reorganisation of the Kowloon supply system, and arranged the overhead transmission for the leased territory.

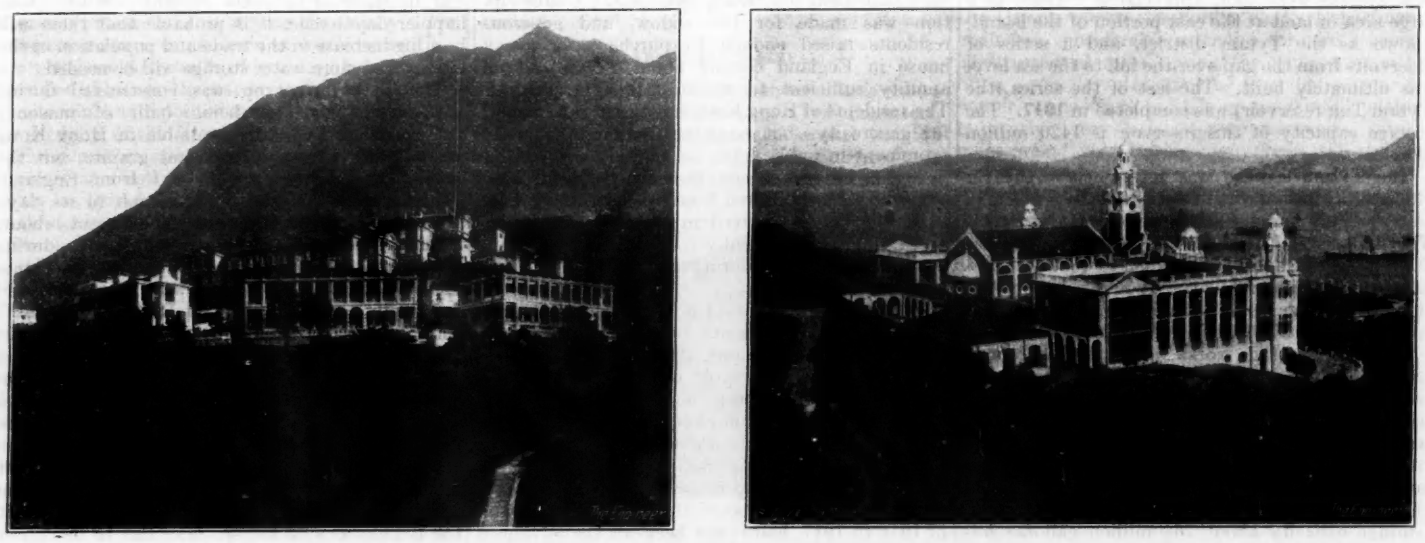
Technical Education

It is notable that in the very early days of the Colony efforts were made to provide schools for Chinese and other nationalities. In due course the local Government established primary and secondary schools; many of the Chinese who became prominent during this century were educated in Hong Kong. About fifty years ago a certain Dr. Patrick Manson and other local British medical practitioners established the Hong Kong College of Medicine, which did excellent work in training students in Western methods of fighting disease. Soon after his arrival in the Colony as Governor, Lord (then Sir Frederick) Lugard advocated the creation of a local university. A Parsee merchant, resident for fifty years in Hong Kong, promised to provide the main buildings; Chinese in various parts of the world and British subjects of other nationalities — including Armenians and Baghdad Jews connected with Hong Kong—subscribed, in about equal parts, to the original endowment fund. The University commenced work in 1912 with Sir Charles Eliot as Vice-Chancellor and Principal, myself as Taikoo Professor of Engineering, and a Registrar. These three full-time appointments were supplemented by part-time lecturers, all Europeans. In 1939 there were twenty-eight full-time British members of the staff, recruited in England, and a number of Chinese lecturers and demonstrators.

In 1912 the total revenue of the University was about 80,000 dollars and in 1939 it exceeded 1,000,000 dollars. Meantime over two million dollars had been spent on new buildings, British engineering firms and shipping companies had contributed gifts of machinery, free freight, &c., to the value of over £40,000, and both the local Government and the War Office in London had granted considerable areas of land for extensions so that the area in possession of the University must now exceed 1¼ million square feet.

For nearly twenty-five years the standard of instruction has been maintained in engineering subjects by appointing assessors who are examiners in the University of London. Every year they have certified that certain candidates have reached the standard required for an honours degree in London. Anyone who has had experience with Chinese students will probably agree that they are not only intelligent, but very industrious. The engineering students in Hong Kong came from every one of the eighteen provinces in China, from Malaya, Java, Sumatra, Indo-China and other parts of the Far East.

Soon after my arrival in Hong Kong an opportunity was taken to advocate technical education for artisans. The local officials, who had helped to create the University, rather resented the statement that it was then more important to have technical education for artisans than for University students, as the latter would be handicapped in China unless they had available workmen trained to handle modern machinery. Many years later the Government appointed a Committee, which recommended the creation of a Trade School. That has been established, has done excellent work, as has also a Technical Institute in Hong Kong.



University of Hong Kong—Residential Buildings and Main Building

These developments in technical education in the Colony have not been without influence in other parts of the Far East. There is, however, a great danger that there will be more concentration on University training than on the training of foremen and artisans. It is my conviction that the Chinese Government and foreign friends of China should encourage the development of Trade Schools and Technical Institutes rather than the extension of University education. The Chinese artisan is a splendid workman and at times is most ingenious. He is, it seems to me, the great hope of China.

Conclusion

The story of applied science developments in the Colony of Hong Kong has been told only in rough outline. During my long residence there it was my delight to make extensive notes on this subject, and to collect many diagrams and illustrations. These, and many other treasured possessions, accumulated during travels in the Far East, survived the journey home, only to be destroyed by enemy action. But the Union Jack still flies over the Colony of Hong Kong, and that is what matters most of all. It is impossible for us who know and love the little outpost of Empire and who believe in the great mission which applied

science can accomplish in Asia, if it is utilised for the benefit of humanity—it is impossible for us to believe that the flag will ever be hauled down and replaced by the crooked cross. And so we can still think of the new works that will be carried out when peace returns, still hold fast to the faith that the British will, in the future as in the past, fight successfully against poverty and disease in Asia, when at last the fight against "that bad man" has been won and engineers will be free to forget works of destruction in their work for civilisation.

Great Ouse Flood Protection

No. I

IN 1937, it will be remembered, as a result of heavy rainfall, there was serious flooding in the Fenlands and a grave risk of the failure of river banks, especially in the area drained by the Great Ouse and its tributaries. In 1938, again, the flood waters threatened to overtop or break down the banks. As a consequence, a number of schemes were put forward for bringing about an improvement of the conditions, and in April of that year the Ministry of Agriculture appointed Sir Murdoch MacDonald and Partners, of 72, Victoria Street, London, to formulate a scheme, in conjunction with the River Great Ouse Catchment Board, the controlling authority for the area mainly concerned. That firm of consulting engineers evolved a scheme within a few months and detailed surveys were subsequently carried out to determine the practicability, magnitude, and cost of the works involved. A report was recently issued by Sir Murdoch MacDonald and Partners to the Board. It deals with the conditions ruling the problem of draining the Fens and analyses critically the various schemes that have been propounded from time to time for bringing about an improvement of the conditions. The following is an abstract of that report.

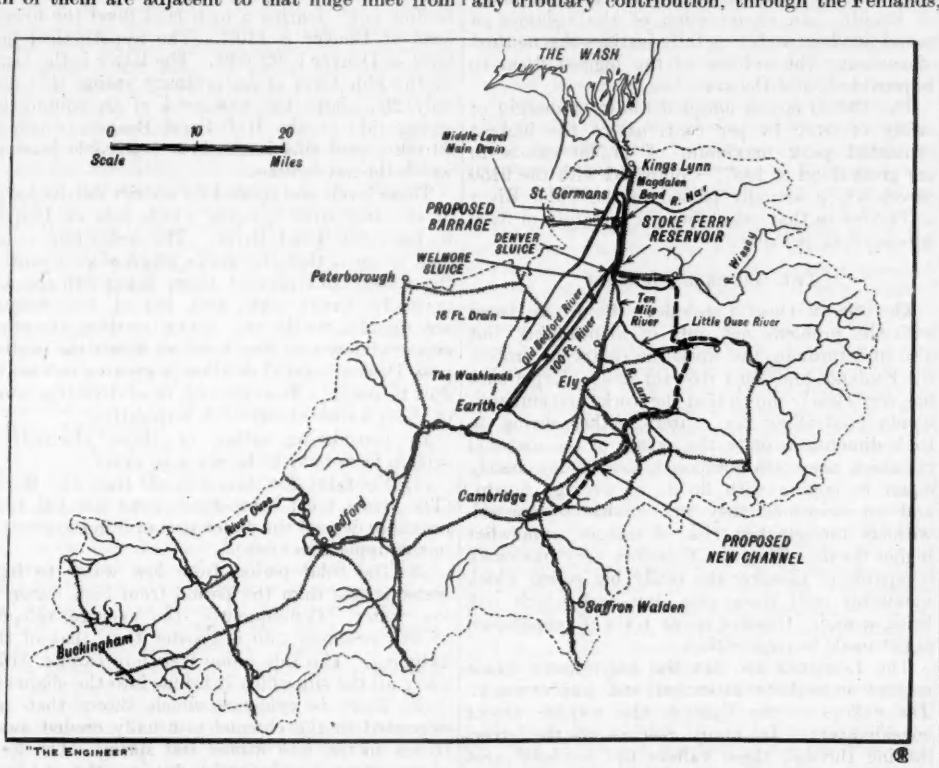
General Statement and Description of Area

The River Great Ouse Catchment Board controls one of a number of contiguous districts, in all of which somewhat similar problems have arisen. All of them are adjacent to that huge inlet from the North Sea, called the Wash, which is roughly rectangular in form, its width being 12 miles at the outer end and 16 miles at the inner, with a length of 18 miles. It is the sea basin into which flow rivers collectively draining some 5850 square miles of territory.

The rivers flowing into the Wash have the somewhat unusual experience of having silt deposited in their channels, which has been brought into them by the sea and not down from the land by the rivers themselves.

The River Great Ouse Catchment Board was formed so that it could control the whole catchment area of the Great Ouse and its tributaries, from their source to the sea, in the interests of agriculture. Its area contains 2,047,880 acres divided into Uplands and Lowlands. The Lowlands, practically all served by pump drainage, are divided into two main systems, called respectively the Middle Level, of 181,070 acres, and the South Level, of 189,100 acres in extent. In addition to these two main blocks of Lowlands, there are the Sutton, Mepal, Manea, and Welney areas of 17,930 acres on the west side of the Washlands, which discharge their drainage into the Tidal River some short distance below Denver. The Washlands is the name given to the 20-mile long and narrow strip of land (it is about ⅜ mile wide) below Earith, between the Old Bedford and the Hundred Foot Rivers, which has an area of 4870 acres. Below Denver there lies another area of 169,650 acres, including the land drained by the River Nar. All this area drains into the stream called the Tidal River, whose channel begins at the confluence of the Hundred Foot and the Ten Mile Rivers. As its name implies, the Tidal River is subject to the flow and ebb of each tide. In this area the division between Uplands and Lowlands is not defined. The Board's engineers have had no reason hitherto to inquire how much there is of each class.

Two river systems and their respective tributaries divide the catchment area of the bulk of the Uplands or hilly country between them. The larger Upland system is that of the Great Ouse which drains to Earith. Its catchment area is 752,000 acres. Its waters are carried, without any tributary contribution, through the Fenlands, along the boundary between the Middle and South levels, by means of the channels of the Old Bedford and the Hundred Foot Rivers, to join the Tidal River at Denver. The other system, formed by the Cambridge and Norfolk Rivers, drains to the Ten Mile River and has an Upland catchment area of 733,260 acres; but as the South Level waters are pumped into the system, the latter's area of 189,100 acres has to be added when considering the water volumes that reach Denver. The total area then becomes 922,360 acres. The following table shows how each division is associated with the others in the disposal of its waters:



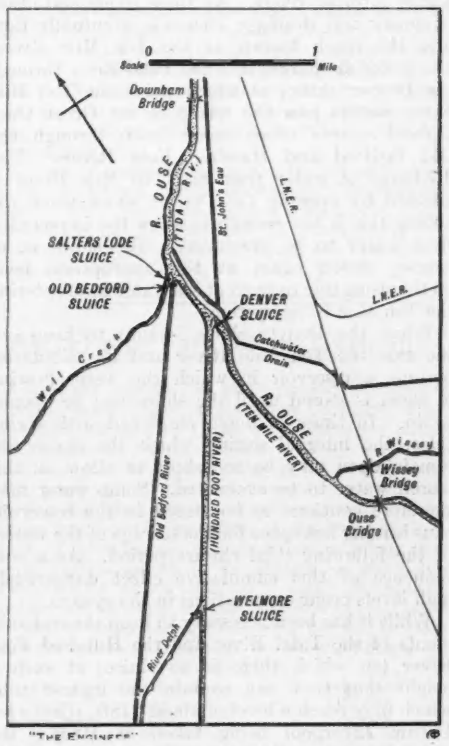
MAP OF THE GREAT OUSE CATCHMENT AREA

Table of Areas in the Catchment Discharging into the Tidal River at Denver

	Acres.	Acres.
A. From the Hundred Foot River:		
(1) Uplands above Earith	752,000	
(2) The Washlands	4,870	
		756,870
B. From the Ten Mile River:		
(1) Uplands	733,260	
(2) South Level	189,100	
Total area draining through Denver		922,360
Discharging into the Tidal River Below Denver		
(1) Sutton, Mepal, Manea, and Welney areas	17,930	
(2) Middle Level	181,070	
(3) River Nar and other areas below Denver	169,650	
		368,650
Total area of catchment ...		2,047,880

The Western Uplands and the Middle Level

At one time apparently all the rivers of the whole catchment area joined the Nene at Wisbech and flowed with it to the sea. At some distant period they were made to flow to Denver and thence down the Tidal River to King's Lynn, whilst later, in the seventeenth century, the Old Bedford and the Hundred Foot Rivers were dug to carry the Upper Ouse waters in a direct course across the Fens from Earith to Denver, and so also to the sea, *viâ* the Tidal River. It will be seen from an examination of the map, and from what has been stated, that Upland water from above Earith is now carried clear of the Middle Level, and runs along its eastern edge, whilst in the case of the South Level all the water entering it is conveyed through the heart of its area. The Middle Level does not, therefore, have the complication of having to deal with Upland water on a large scale. Its own rainfall and subsoil waters are drained to a number of pumping stations, which lift them into higher flowing drains, all of which eventually reach the Middle Level main drain flowing to St. Germans, where it joins the Tidal River, about 4½ miles upstream of King's Lynn. At St. Germans there is a large pumping station which is capable of giving, and does ensure, adequate drainage to the Middle Level system under all conditions.



DETAIL MAP OF THE AREA ROUND DENVER SLUICE

It can be assumed that the Middle Level is in no danger from Upland flood waters, or from the tide. There are, however, very important qualifications to this statement. It will only be true, provided that the banks of the Old Bedford and Tidal Rivers are maintained to adequate levels and dimensions, and protected where necessary from erosion, and provided also that the Welmore sluice, at the lower end of the Washland area, is able, and is allowed, to discharge before the water in the Washlands rises to such a height that there might be danger of a breach in the Barrier Bank on the left side of the Old Bedford River. This Washlands area is used as a huge reservoir to contain excess flood water which can spill over on to it everywhere for the whole length of the

Old Bedford River. It was a brilliant conception to form the Washlands and to use it in the manner in which it has now functioned for ages. In the case of extreme danger of flooding in the Ten Mile River, there is a very natural and impelling tendency on the part of the engineer in charge of the whole of the Board's system to regulate on the Welmore Lake sluice, which controls the Washlands and the Old Bedford River, and thus hold up more water and maintain a higher level in the Washlands than would be otherwise necessary. The engineer would do this regulation in order to allow the Tidal River to fall low enough to enable the Ten Mile River in turn to discharge more freely. A situation of this kind arose in recent years, during which water in the Washlands was held up very high to the danger of the Middle Level. A satisfactory scheme which would prevent the danger of flooding in the South Level is therefore also of vital importance to the Middle Level.

The Eastern Uplands and the South Level

The South Level is in a much more dangerous position than the Middle Level, because the Cam, Lark, Little Ouse, Wissey, and other streams, carry all the Upland waters through the very heart of its area. The surrounding lowlands are drained by a large number of pumps lifting their waters into the rivers. All these rivers and other tributary and drainage channels eventually flow into the reach known as the Ten Mile River. The latter discharges into the Tidal River through the Denver sluice, at which point the Ten Mile River waters join the whole of the Great Ouse Upland waters which come down through the Old Bedford and Hundred Foot Rivers. The discharge of water from the Ten Mile River is effected by opening the Denver sluice when the ebbing tide is low enough to allow the impounded river water to be evacuated. The sluice is, of course, closed again at the appropriate level on the rising tide to prevent sea water from entering the Ten Mile River system.

When the Denver sluice is shut to keep out the tide the Ten Mile River and its tributaries become a reservoir in which the water flowing in them is stored until the sluice can be opened again. In times of flood, combined with spring tides, the interval during which the sluice can remain open may be too short to allow all this stored water to be evacuated. Some water may therefore continue to be stored in the reservoir, thus leaving less space for the storage of the waters of the following tidal closure period. As a consequence of this cumulative effect dangerously high levels occur on occasions in the system.

While it has been necessary to keep the embankments of the Tidal River and the Hundred Foot River (on which there is no sluice) at such a height that they can contain the highest tide, which may reach a level of about 118ft. (Ordnance Datum Liverpool being taken as 100ft.), the embankments of the system formed by the Ten Mile River and its tributaries have been maintained at a lower level, because the tide is not allowed to flow into them. The minimum height of these embankments is now just about 112·5ft., and as the necessity for reservoir capacity during floods caused the water to approach very near to, if not actually reach, that level more than once in recent years, the condition is one of great danger to the South Level, especially so as in many places the embankments are of inadequate cross section, composed of poor material, and built on a layer of peat which is steadily shrinking, and which, it can be predicted, will one day wholly shrivel away.

Fresh and Sea Water

In the case of the sea water, the volume would be immaterial if it did not carry silt. As it does carry silt, the less volume entering the channel, and consequently the less the ratio of sea water to fresh water, the better, because the channel of the river is really kept clear by the fresh water.

It is obvious from the foregoing consideration that any increase in the proportion of sea water to fresh water which can be done by widening or deepening the channel will entail inevitably more silting.

To arrive at an estimate of the volume of fresh water any given channel may have to pass, all that can be done is to note the maximum volume of former exceptional storms, and, while making provision to meet the recurrence of the heaviest, in addition, provide an ample margin of safety in case the former known heaviest should be exceeded by some future storm.

The maximum discharge which has been measured at Earith is 7300 cusecs in February, 1940, and it is known to have been taken on a really phenomenally high flood. It is proposed to add about 5 per cent. to this figure, which will then become 7700 cusecs, and to take that figure as the probable future maximum which may have to be dealt with at Earith, or, indeed, at any other point between it and Denver, if there be no reduction owing to storage in the Washlands. The maximum discharge from the other Upland and South Level areas of 922,360 acres is estimated at 6000 cusecs, the volume which, if it were possible for it to reach Denver and pass through the sluice, would be the peak discharge of the Ten Mile River at that place based upon the phenomenally high flood of 1939. If a factor of safety of 5 per cent. is added to the above estimated discharge of 6000 cusecs, the figure for which provision ought to be made becomes 6300 cusecs.

While in the future it is necessary to regard discharges of 7700 cusecs in the western, and 6300 cusecs in the eastern area, as the volumes to be provided against within their respective areas, yet it would not be justifiable to regard these figures, loaded as they are with safety factors, as the volume which will have to be dealt with after they join each other at Denver. That a heavy storm should occur simultaneously over the whole area, which comprises over 2,000,000 acres, or about 3000 square miles, and be of an intensity everywhere equal to that which produced in separate years and in separate areas, the really phenomenal high floods referred to is so unlikely as to be justifiably neglected. The only reasonable course, therefore, is to take the estimated possible discharge of the western area, or 7700 cusecs, and add it to an ordinary high flood in the eastern area, or *vice versa*. As the phenomenally high flood in the latter area was 6000 cusecs, an ordinary high flood may be assumed to be that which would not exceed 5300 cusecs. This is similar to the 1937 flood discharge.

The joint volume of these two floods, a phenomenally high one in the western, and an ordinary flood in the eastern area, becomes 13,000 cusecs, and is the maximum quantity which it is thought would pass Denver on some future occasion in the worst circumstances reasonably imaginable. *Vice versa*, the total would be 6300 and 6700= 13,000 cusecs; 6500 cusecs was the 1937 discharge at Earith. An examination of the volumes of recent floods in each area fully justifies this method of assessing the volume of the biggest flood to be provided for at Denver.

The 13,000 cusecs adopted allows a margin of safety of over 13 per cent. above the highest estimated peak maximum of 11,500 cusecs in the great flood of 1937. Compared with the 9150 cusecs which actually passed in the Tidal River at Denver in that year, there is a margin of 3850 cusecs, or 42 per cent.

The General Problem

The Great Ouse Catchment Board is faced with the problem, not only of maintaining, but also of improving the works necessary to protect the Fenlands and other riverain areas. Experience has very clearly shown that the works and embankments controlling the waters, either owing to their dimensions or to the nature of the material of which they are composed, are to-day barely equal to coping with floods of average height, and on occasions they are unable to control, without the greatest risk of danger, somewhat higher floods. They are therefore very obviously incapable of meeting the really big storm which inevitably will come one day and which will bring a major disaster in its train if preparation is not made to cope with it.

The Lowlands are not the only places which require immediate attention and improvement. The valleys of the Uplands also require urgent consideration. In many reaches of the rivers flowing through these valleys the sectional area of the troughs of the rivers is not large enough to prevent the extensive flooding of land on either side during almost every heavy rainstorm; this is particularly the case with the Great Ouse above Earith.

Condition and Use of the Tidal River

The Tidal River is really in two sections—the Hundred Foot River and the "Tidal River." The latter has local names, in its lower reaches, of the Eau Brink and the Marsh Cut. The first, or Hundred Foot River, begins at Earith and ends at Denver. It is tidal for its whole length and carries, with its parallel channel the Old Bedford River, all the waters of the Uplands beyond Earith. At Denver the "Tidal River" begins. The waters of a large part of the catchment area reach the Tidal River at Denver. The Middle Level drainage joins it at St. Germans, while the River Nar is its lowest affluent and reaches it near King's Lynn. If the longitudinal section is examined, it is found that the existing bed slope of the Tidal River, if an average line be run through its very considerable irregularities, is very flat, and if it be taken to begin with a level of 92·00 at Denver, it only falls to 90·00 at a point about 9 miles nearer the sea. The water slope, on the other hand, when the river is in flood and the tide out, is 13·4in. per mile. There is therefore a fall in the water surface of about 10ft. in 9 miles, whereas the bed only falls 2ft. Consequently, the river has to widen as the depth of water lessens from Denver seawards.

Obviously the question which arises to the mind is whether the channel can be altered in any way with a view to enable it more beneficially to dispose of its waters, or, if not, what other measures can be adopted to secure the same object? In considering any type of alteration sea levels are an important factor which must be taken into account. The highest sea level is that of an equinoctial tide. It can reach a level of 118ft. at Hull Sand Beacon in the Wash, when accompanied by a North Sea surge. The ebb of these tides can fall to 90·00ft. at the same point.

The Tidal River embankments must cope with the very highest level of the tides. It may happen that the highest tide level synchronises with a land flood due to a rainstorm or period of melting snow or both, a conjunction which is not infrequent about the vernal equinox. The land waters under the present conditions are choked back by the tide. Landstorms may last over several days, and consequently a part of them, and possibly the peak volume, may have to be discharged on higher ebbs than the low one of a phenomenally high tide. It is proposed, therefore, to use for calculation purposes the ebb level of an ordinary spring tide (92·0ft.) as the lowest level on which the peak volume of flood should pass out to sea.

The controlling levels at Denver are therefore 118·00ft., the highest recorded level of a tide, and the lowest level of the ebb of an ordinary spring tide, or 92ft., which, of course, would only be reached at Denver if there was no fresh water to flow out. During a high land flood the lowest level at Denver is 110ft. The hypothetical bed level at Denver is 92·00ft. The latter is the same as the ebb level of an ordinary spring tide and only 2ft. above the ebb level of an equinoctial spring tide at the Hull Sand Beacon, which is 90·00ft., and this is the lowest possible level to which the sea recedes.

These levels and conditions restrict the discharge of the two river systems which join at Denver to form the Tidal River. The restriction is, in fact, so great that the works which should control the waters and prevent them doing damage are normally barely able, and, indeed, occasionally are unable, to do so. Some method therefore either of lowering the level at which the waters pass Denver (and thus allow a greater volume to flow to sea in a fixed period), or of diverting some of these waters elsewhere is imperative.

In considering either of these alternatives certain facts have to be borne in mind:

(1) The tidal flow brings in silt from the Wash. (The rivers must bring down some silt, but they probably deposit the major part of it in the streams in the upper Fen area.)

(2) The tidal period from low water to high water is less than the period from high water to low water. Consequently, the average velocity of the incoming tide is greater than that of the outgoing. The tide alone therefore cannot carry away all the silt which it brings into the channel.

(3) There is evidence which shows that silt deposited in the channel is usually eroded away to sea in the late winter and spring. The foregoing effect is obviously due to the seasonal changes in the volume of fresh water flowing down the river, which is usually low in summer and autumn, and high in winter and spring; the removal of the silt is also apparently very largely due to the occasional heavy storm floods interspersed throughout the latter seasons.

(4) The river trough for many years on the whole has maintained its sectional area. (Some major changes have been noted, but alterations made in the Eau Brink and the Marsh Cut are sufficient to account for them.)

The Tidal River, in fact, has put itself in a state of *régime* where all the factors balance so

that, over a long period of years, the amount of silt deposited is equal to the amount of silt removed. It is obvious from the foregoing that any alteration of the section of the river by either widening, or deepening, while providing the same bed width, or both, will flatten the gradient at which the water flows, and this again, in turn, will reduce the velocity of the current and its erosive power. Silting consequently will follow until the original dimensions and gradients once again hold sway. The only alteration permissible in a silt-laden river is a shortening of the length of the channel. Such shortening is feasible on the Tidal River between Denver and the sea if bends and curves are cut out of its course, as much as practicable. The water level at the sea cannot be altered, but the same gradient can be maintained in the water surface as before, and consequently the same erosive power maintained to remove silt, although the water level at the upper end, say, near Denver, of the shortened channel, will be lowered.

(To be continued)

The Gas Research Board

AN epoch-marking event in the history of the gas industry, of which the founder was William Murdoch, has recently taken place in the establishment of the Gas Research Board.

This body, formed by the Institution of Gas Engineers, the Society of British Gas Industries, and the Refractory Materials Joint Committee of the Gas Research Board and the British Refractories Research Association, would, but for the outbreak of war, have started to function last year. The Board, however, has just issued its first annual report, which normally would form the means by which the Council of the Board would render an account of its stewardship to the members, and an opportunity for discussion of the report would be afforded at the annual general meeting of the Gas Research Board, which would take place during the Autumn Meeting of the Institution of Gas Engineers. Owing to the present abnormal circumstances, and for reasons which become apparent on reading the report, the nature of the document is somewhat different from that which, it is hoped, future annual reports will assume.

The first meeting of the Council of the Board was held on July 25th, 1939, when the following appointments were announced :—

President : Sir David Milne-Watson. Secretary : Dr. W. T. K. Braunholtz. Members of the Council : Nominated by the Institution of Gas Engineers—Messrs. E. V. Evans (London), Chairman, E. Crowther (Newcastle-upon-Tyne), J. E. Davis (London), George Dixon (Nottingham), H. Hollings (London), Stephen Lacey (London), C. A. Masterman (London), T. F. E. Rhead (Birmingham), H. C. Smith (London) ; nominated members of the Council by the Society of British Gas Industries—Messrs. A. G. Grant (Darlington), H. Hartley (Birmingham), D. M. Henshaw (Huddersfield), R. J. Rogers (Birmingham), E. W. Smith (London), Ernest West (Manchester).

It was resolved to invite Professor D. T. A. Townend, Livesey Professor of Gas Engineering at the University of Leeds, to be a co-opted member of the Council.

The Councils of the Institution of Gas Engineers and the Society of British Gas Industries were then invited each to nominate one Vice-President. The former nominated its President, Mr. George Dixon (Nottingham), and the latter nominated Sir Frederick J. West (Manchester).

As the Board would require to raise funds and to expend them with a limited liability to its members, and as, at a later date, it would probably desire to obtain grant of letters patent covering its discoveries and to grant licences thereunder, it would be necessary for the Gas Research Board to become a body corporate in the sense of the Companies Act, 1929, either by trust deed or by articles of association. A drafting panel was therefore formed consisting of Mr. E. V. Evans as Chairman, and Mr. R. J. Rogers, Dr. E. W. Smith, and Mr. H. C. Smith.

This panel in drafting the articles of association paid due regard to the possibility that at some future time the Gas Research Board might wish to become associated with the Department of Scientific and Industrial Research, and perhaps to receive a grant for the purposes of the Board's work as a research association for the gas industry.

That Department has therefore been consulted in the preparation of the articles of association, in order to avoid there being included in them any matter which would be a hindrance to such association, should it be desired at a later date.

The draft articles are at the moment the subject of discussions with the Board of Trade, and it is anticipated that the establishment of a normal constitution will soon be a *fait accompli*.

A Finance Committee and an Emergency Panel have been formed. Temporary financial arrangements for carrying on the work of the Board have had perforce to be made. The Institution of Gas Engineers has agreed to meet the expenses of the Gas Research Board in the same way that hitherto it has met the research expenses of the Institution, out of its Special Purposes Fund. It is not intended for the present that the Board should possess separate offices or laboratories ; the Council of the Institution has agreed to allow the use of its office facilities and staff at Gas Industry House, Grosvenor Place, for a charge agreed to between the Finance Committees of the Board and of the Institution. A particularly valuable service which has been rendered by the Institution to the newly formed Board has been in giving permission for its able secretary, Dr. Braunholtz, to be the first secretary of the Board.

It has been appreciated that the success of the venture of launching the Board depended to a large extent upon the selection of a competent and fully qualified Director of Research. Shortly before war broke out applications for this important post were invited by advertisements in the technical Press, and in certain national periodicals.

A number of replies was received, but by that time the nation was in the throes of war, and it was felt that, owing to demands likely to be made upon the services of many of the applicants, it would be a most unsuitable moment to make any appointment to the directorship. With the ready consent of the Council of the Institution of Gas Engineers, its secretary, Dr. Braunholtz, was asked, and consented, to add to his already heavy responsibility that of Acting-Director of the Gas Research Board.

Frequent meetings of the Emergency Panel have been held during the year. It has dealt with a number of pressing matters, particularly those arising from questions put to the Gas Research Board from time to time by various Government Departments.

As to membership of the Board, it has been decided that, subject to certain safeguards, it shall comprise persons and corporate bodies coming within the following categories :—

(a) *Ordinary Members.*—British subjects carrying on business or otherwise engaged in the gas industry, and those British corporations carrying on business, who shall be admitted as members of the Board.

(b) *Associate Members.*—These are to be such members of any class of the Institution of Gas Engineers or other scientific workers or persons engaged in or connected with the gas industry, or likely to assist in its development as shall be so admitted to membership, provided always that no person shall be eligible for associate membership who is employed by a corporation or firm eligible for ordinary membership, either itself or through a representative, but which, or a representative of which, has not been admitted as an Ordinary Member.

(c) *Delegate Members* are to be delegates of other associations established for kindred purposes.

(d) *Honorary Members* are to be persons, whether entitled or not to become Members, under the above provisions, and nominated for membership by the Council of the Board for special services or for special causes, and elected at a general meeting.

The Council of the Institution having agreed to give financial support from its Special Purposes Fund, it follows that any incorporated gas undertaking which now subscribes to the funds of the national bodies will become eligible, without further payment, for Ordinary Membership, and, if elected, will be entitled to nominate a person to act as its representative, subject to certain safeguards. British corporations engaged in the manufacture of plant and appliances for the gas industry will also be eligible for Ordinary Membership, while firms or other unincorporated associations similarly engaged will be eligible to nominate one of their members for membership on their behalf. The class of Associate Member will permit individuals who may not be nominated as the representative of a member corporation or firms to become associated with the work of the Gas Research Board.

Various committees have been formed in connection with the Board. The committee generally referred to as the Joint Research Committee has been previously a joint committee of the Institution of Gas Engineers and Leeds University, but, with the consent of the respective Councils of the Institution and of the University, it has been agreed that in future it shall be a Joint Research Committee of the Gas Research Board and Leeds University.

The position of the research chemists and assistants attached to this Committee has been reviewed, and it has been decided that Dr. F. J. Dent and Dr. A. Key shall be research chemists of the Gas Research Board, seconded to the Joint Research Committee for carrying out the work of that Committee, while the other members of the research staff shall remain as research staff to the Joint Research Committee. The Gas Research Board will accept all such responsibilities towards the research staff as had previously been borne by the Institution of Gas Engineers.

The Refractory Materials Joint Committee had previously been a joint committee of the Institution of Gas Engineers, the Society of British Gas Industries, and the British Refractories Research Association. The Councils of these respective bodies have now agreed that the Committee shall in future be a joint committee of the Gas Research Board and the British Refractories Research Association.

An information bureau, which, it is hoped, will in course of time be of great assistance to the gas industry, will be an outstanding feature of the work of the new Gas Research Board. It is felt that there has not hitherto existed in the gas industry a central bureau through which technical information touching upon the multifarious interests of the gas industry can be collected together and made readily accessible to those who may wish to apply the information in their work.

Some of the larger gas undertakings and firms, both on the supply and manufacturing sides, have made their own arrangements to provide such facilities for their staff, and in certain instances have generously extended these facilities to others outside their own organisations. The co-operation of all such private bureaux is sought, and has, indeed, in several instances been freely offered already. It is clear that the establishment of such a bureau involves a great deal of work and even without the interruption of war it would have been some time before the bureau could have functioned with full efficiency. In existing circumstances the project becomes even more difficult, but, as with other sections of the Board's work, the Council feels that although progress may be slower than in normal times the prosecution of all the projects begun and contemplated should continue.

As already stated, the autumn meeting of the Institution of Gas Engineers will provide the opportunity for presenting to the members of the Board a report of its work during the previous year. The communications and the discussions to which they give rise it is proposed to insert in the " Transactions " of the Institution.

Here the suggestion occurs that it might be advantageous to publish the Autumn Meeting " Transactions " as a separate bound volume. The " Transactions " of the Institution containing an account of both the Summer and Autumn Meetings now occupy a bulky volume, somewhat difficult to handle, as it runs into some thousand pages, with the addition of illustrations.

The above gives information of the salient features of this important newly constituted Gas Research Board. There can be no doubt, with all the distinguished and capable leaders of the gas industry bent on making it a success, it will be an enormous benefit to all who are concerned.

Air Force Targets in Germany

FOR many months we have printed at frequent intervals descriptions of places in Germany which have been bombed by Great Britain and her Allies. The targets have been selected week by week with some attention to topical interest, or what editors call " news value," but one has only to look at a now familiar poster to see how frequently the same district receives the attention of the Bomber Command. Topical interest may therefore recur long after our description appeared. To satisfy it, we give below a complete list of the series up to date. The articles have excited so much interest that it is our intention to continue them and the following list will be published from time to time with the latest additions :—

		1940.
1.	Kiel and the Kiel Canal	July 12th
2.	Hamm Marshalling Yard	July 12th
3.	Dortmund-Ems Canal	July 26th
4.	Emden and Wilhelmshaven	August 9th
5.	Junkers Aircraft Works at Dessau	August 30th
6.	Two Berlin Power Stations (Klingenberg and West	September 27th
7.	Map showing Bombing Attacks on the Ruhr District	October 11th
8.	The Lauta Aluminium Works	October 18th
9.	Bitterfeld Aluminium Works	October 25th
10.	Rheinfelden Aluminium Works	November 1st
11.	Leuna Works of the I.G. Farbenindustrie	November 8th
12.	Pölitz Hydrogenation Works, near Stettin	November 15th
13.	Sterkrade-Holten Oil Works	November 22nd
14.	Duisburg-Ruhrort Harbour	November 29th
15.	Port of Hamburg and its Shipbuilding Industry	December 6th
16.	Cologne and its Environs	December 20th
		1941.
17.	City and Port of Mannheim	February 14th
18.	Ludwigshafen-am-Rhein	February 21st

A CIRCULAR LOOM.—A circular loom producing cloth in the form of an endless sack instead of the ordinary strip has been invented by S. A. Dynnik, a Soviet engineer at the Bast Fibres Institute in Moscow. The warp of this loom differs considerably from the usual, being in the form of a tent with two shuttles revolving in a circle. In ordinary looms the weaving is done by a shuttle moving at regular intervals, so that for more than two-thirds of the time it is idle. In Dynnik's loom there is a continuous circular movement of the two shuttles, which eliminates unproductive expenditure of energy. As a result, this machine, besides laying the thread evenly, has, it is asserted, twice the capacity of an ordinary loom. It occupies only two-thirds of the space, and will, it is claimed, considerably lower the cost of building mills. The cop or supply of weft thread in Dynnik's loom weighs 21 oz., fifteen times more than the cop of an ordinary loom. As a result, the spindles in the new loom have to be changed once for every fifteen times in the ordinary looms. Moreover, there will, it is contended, be much less tearing of the thread. The Bast Fibres Institute estimates that if all the sacking in the Soviet Union were to be produced on circular looms, 13 million roubles would be saved annually. The machine can also be used for weaving linen, cotton, and woollen fabrics.

The Engineer

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HONG KONG

A WITTY statesman, whose name for the moment escapes us, once remarked that "The British Empire was acquired in a fit of absent-mindedness." The almost casual way in which Great Britain came into possession of her Dominions, coupled with the fact that in many cases private enterprise, from Queen Elizabeth's time downwards, did all the initial spade work, lends substance to that quip. There are few examples of deliberate military aggression, but many of friendly concession for mutual advantage. In all these cases the engineer has soon become paramount. The politician and statesmen may make the contracts, the civil and military services may regulate and control them, but it is in real truth the engineer who is the Empire builder. It is he who, by his ships, railways and roads, effects the interchange of goods; it is he who improves the health of tropical climes by sanitation, drainage, and water supply; it is he who develops the local minerals; it is he who provides the plant for agriculture and agricultural products. Without him the Empire would disintegrate into its component parts, and each of the parts slip back again into its aboriginal condition. He it is who is the great civiliser, not in material things alone, but in moral also. For wherever he goes he carries with him a trained intellect, a faith in upright dealing, courage of a high order, and the spirit of great enterprise. The politician matches wile against wile and subtlety against subtlety. The engineer goes straight to the thing that has to be done and does it. He comes in after the politician and the financier have opened the door for him, concerned only to do what he sees should be done, and what can be done with the technical knowledge and means at his command.

The development of Hong Kong, so admirably described in the series by Dr. Middleton Smith, which is concluded this week in these pages, provides a brilliant example of the engineer as an Empire builder. Dr. Smith tells us how the engineer made roads and railways, built docks and harbours, provided water supply and sanitation, gave good lighting and carried out those innumerable services that gradually converted a barren and pestilential island, inhabited by five thousand Chinese illiterates, mostly pirates, into a great and healthy city with a population of over one million, and a port of the first order. It is just a hundred years since the Union Jack was hoisted for the first time on the island. Progress was at first slow; there was opposition, not only from the Chinese, but from politicians at home and even Governors on the spot. The death-rate from storm, pestilence and famine was enormous, and political troubles were rife. Sixteen years after Hong Kong had become a Crown Colony *The Times* wrote in a leading article that the island was "always connected with some fatal pestilence, some doubtful war, or some discreditable internal squabble." But the engineers went on with their work, having an abounding faith that plague and epidemic could be conquered by drainage, sanitation, and good water, and that the material advancement would follow fast upon the improvement of land and water communications. Fortunately, they were supported by the sympathy of a few far-seeing Chinese and by the courage of the British investor. As early as 1843 a Committee of Public Health was established to enforce a rigid system of sanitary rules to circumvent the prevailing habits of the people, which resulted in frequent outbreaks of enteric diseases. Road construction began in 1843, mainly for military purposes. Buildings of native granite began to take the place of matsheds and imported wooden shanties, and in 1847 a large reclamation scheme was begun and completed in the next decade. The Indian Mutiny, 1857, caused a check and set the place by its ears. An attempt was made to poison all the "foreign devils" by putting arsenic in their bread. It was defeated by an excess of zeal; for an overdose put the British on the alert. With the suppression of the Indian mutineers order was restored in China and the path of progress was reopened. About this time the Chinese Maritime Customs Service was founded. Under its ægis engineers carried out great navigational works on the coast of China and Hong Kong, being a nodal point for the distribution of cargo, benefited, and increased its port equipment. In 1847 the tonnage entering and leaving Hong Kong was 500,000; in 1858 it had risen to 1,350,000 and in 1937 was nearly 38,000,000. And whilst all these material and physical improvements were being effected mental development was not being neglected. A university was founded and a London firm—John Swire and Sons, Ltd.—contributed £40,000 to the endowment fund. The first chair in the university was very appropriately the Chair of Engineering—filled for many years by Dr. Middleton Smith—and is called Taikoo, after the name by which the Swire associated companies are known in the East. Of the work done by the university in the education of Chinese students it would be difficult to speak with too much praise.

In 1920 the late Sir Maurice FitzMaurice visited Hong Kong to give advice on harbour improvements. On that occasion he remarked that although he had visited many parts of the world, nowhere had he seen such a great variety of engineering works grouped so closely together as in Hong Kong. That was some eighty years after the cession of the island to Great Britain. In his series Dr. Middleton Smith reviews these works in much detail and brings out the clear and uncontrovertible fact that the greatest of the civilising forces in that community have been exerted by engineers. It is the way of political writers—perhaps because technicalities are obnoxious to them—to attribute advancement to wise governors, but they too often forget that the wisest Government in the world would be powerless in the development of virgin countries without the work of engineers. They forget, too, that the wisest governors are those who take the advice of engineers, recognising that not until countries have been made healthy by sanitation, drainage and water supply can the seeds of progress be sown profitably, and that not until means of internal and external communication have been provided, developed or improved can profitable contact with the rest of the world be ensured. We ask for no more shining example of those facts than Hong Kong provides. Under the guiding hand of British and native engineers it has risen from a poor island with no greater merits than its geographical situation and a natural harbour into a healthy and wealthy outpost of Eastern trade. As a Chinese official remarked some years ago, "China ceded to Britain a granite rock and has since received in return a mountain of gold."

Of Things

THE metaphysician, who, as we all know, is one who searches in a dark room for a black cat that isn't there, has tried, time out of mind, to get common sensible people all muddled up and confused about the reality of things. He wants us to believe that nothing really exists except in our thoughts. In fact, that the cat is really there if we think it is, and it cannot possibly be there whatever manifestations of its existence it may make if we don't think it is. Other metaphysicians have tried to persuade us that we cannot think at all until we are in possession of the names of things and ideas. In other words, no one can reason about the action of a valve gear till he can name the links, rods, pins, levers, and so on. Even with regard to mathematics Hardy tells us in his much-discussed "Apology" that "there is no sort of agreement about the nature of mathematical reality among either mathematicians or philosophers. Some hold that it is 'mental' and that in some sense we construct it; others that it is outside and independent of us." If engineers bothered their heads about such things they would soon come to the conclusion that, like the metaphysicians themselves, they didn't know where they were. Fortunate indeed it is that the reality of things no more influences the action of the common pump or the steam turbine than the Einstein theory affects terrestrial mechanics. We can all be sturdy Johnsonians and sufficiently satisfied of the real existence of things if we can thump our sticks upon them.

Were we concerned only with existence of things we could leave it at that. But in technology, as in other affairs of life, we need something more; we must give names to things and must all be agreed about what the names mean. It is no good asserting that a brick is not merely "mental" if we cannot call it a brick. Ordinarily we cannot communicate our ideas to others if we lack names by which to express them. We say "ordinarily" because it is more than open to suspicion that a great many people use the names and have little or no true conception of the "things" to which they belong. Does everyone know what the now familiar pH means when he uses it and even if he is wise enough to assert confidently that it stands for hydrogen-ion concentration, has he, having, like Sir Andrew Aguecheek, "no more wit than a Christian or ordinary man" more than a very faint conception of what a hydrogen-ion is? That is the crux of the matter; that we should know what we mean and know that others know what we mean. That is a far, far harder thing than it appears to be. It has been truly said that, just as there can be no opinions when knowledge is complete, so there would be fewer discussions if definitions were perfect in themselves and interpreted by all alike. Our ingenious American cousins are grappling with this ever-living problem in their own way. Whilst only one or two here and there in a double handful of millions has the mental strength of a Kelvin, his weakness is as common as sand on the sea shore. Every man compounded of the common clay—we exclude mathematicians and the intellectual giants who handle conceptions without realities—reaches

a fuller knowledge of things if he can examine a "model" of them, if they be abstract, or handle them in the flesh if they be real. Knowing this, Science Service, of Washington, D.C., is for the modest sum of four dollars a year instructing five thousand Americans in the reality of things by circulating samples of the things themselves. Do you want to know what polarised light is—and "lives there a man with soul so dead" that he does not—then Science Service provides an "optics unit" to make it clear to you; or, be it Christmas time, when everyone ought to know what whey is, and you find yourself able to apply practical tests to samples of candy made with that delectable material. Even if your aspirations are on a higher plane and you wish to convince your family circle that a thunderbolt is not a meteorite, Science Service steps in by sending you a sample of a shooting star so that you may have an optical and tactual something to hurl, figuratively of course, at the heads of the unbelievers. We are informed that fabrics, glass, plastics, taste and even heredity—a ticklish proposition—are scheduled for early appearance.

Let it not be concluded that because we have written lightly of this extension of the kindergarten system we look down upon it with our brows on high. In our heart of hearts, we confess it, we are sorry that five thousand miles of sea separate us from the advantage that will fall to the lot of the happy five thousand Americans who will now be able to satisfy themselves by their five senses of the reality of things. Thus shall true knowledge be expanded; thus shall it come about that when Americans talk of the taste of blue-points, the smell of lilies, the polarisation of light, plastics, or heredity none will have to rely upon the dubious definitions of the dictionary, but will be able to say with his hand on his heart "I know what these things are because I have experienced them through my own senses," and, of even greater moment, he will know that four thousand nine hundred and ninety-nine other Americans will apply to the same things the same meaning that he applies. By this Service the technical museum and the demonstration bench will be brought to your own doorstep, your own letter-box perchance, and real knowledge, as contrasted with book learning, will be expanded.

Obituary

ALBERT HALL

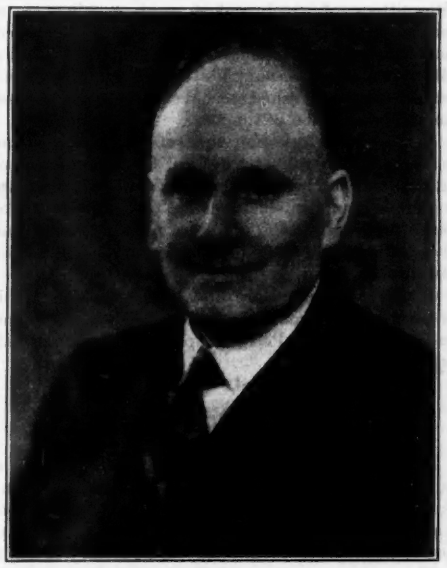
WIDESPREAD sorrow has been caused by the death, as a result of a road accident, on February, 11th, of Mr. Albert Hall, who was for nearly thirty years personal technical assistant to the late Dr. S. Z. de Ferranti.

Mr. Hall was born at Portsmouth in 1878 and entered the Naval Dockyard as an apprentice at the age of fifteen. He gained a Whitworth Exhibition and went to the Royal College of Science to study under Professor John Perry. So thoroughly did he earn the approbation of his teacher that, when in 1902 Ferranti asked his friend Perry to find him a really bright young graduate as a personal assistant, Albert Hall was put forward for the job. Dr. Ferranti had become convinced that the prime mover of the future would be the internal combustion turbine and that its development was to be approached through experience with steam. This determined broadly the lines of investigation on which Mr. Hall worked for the next twelve years. The quest started with experiments on materials to withstand very high temperatures and stresses; the endeavour to improve the means of air compression and the heating of air at constant pressure and experiments on regeneration.

Mr. Hall played an important part in the development of progressive feed heating, patented in 1906, and later in the development of re-superheating. In the Ferranti turbine steam was admitted at 180 lb. gauge and 400 deg. Cent. temperature, exhausted at 18 lb. per square inch and re-superheated to 400 deg. Cent. before being again passed back to the turbine. Final exhaust to the condenser was passed through the regenerator to the feed water system. The higher running temperatures demanded special blades. Experiments with nickel steel led to the introduction of a blade with a soft steel body protected by an outer coating of nickel. The processes of swaging, rolling and welding and the design of the special machinery to carry them out were largely the result of Hall's work. He also assisted in the design of Ferranti's multi-disc self-lubricating thrust to secure an even distribution of the thrust load, which was patented in 1910.

Cotton spinning was another business in which Hall, as Ferranti's assistant, became deeply involved. The general spindle speed was then about 6000 r.p.m. Ferranti had the ambition to raise it to 20,000, and Messrs. Coats were keenly interested co-operators. Electric induction motors for individual spindle drive were discarded in favour of small turbines. They were driven first by water, then by oil, and finally by air. This little air turbine, about 1¾in. in diameter, ran experimentally up to 60,000 r.p.m. The speed selected as safe and satisfactory was 21,000 to 24,000 r.p.m., and the turbine was air lubricated. Technically this work was highly successful, but the relatively high cost of making the equipment has, up to now, prevented its further commercial development.

In 1915, on the request of Viscount Chetwynd, Dr. Ferranti released Mr. Hall to enter the service of the Ministry of Munitions to act as Lord Chetwynd's assistant in the erection and management of the largest factory in England for the manufacture of amatol and the filling of shells, mines and bombs. The factory was at first engaged on filling and finishing by the melt process and when later it turned to the more modern dry



ALBERT HALL

process, the methods of filling employed and all the novel methods of finishing were due to Hall. The factory filled nearly 20 million howitzer shells, in addition to an enormous number of mines and bombs. While engaged on this job and living at the factory Mr. Hall was involved with his household in a tremendous explosion, from which they all miraculously escaped without injury. His infant son, Geoffrey, now a member of the Ferranti staff, was rescued from beneath a girder which had fallen across him without causing so much as a bruise. The house was completely destroyed.

In 1919 he returned to Dr. Ferranti's service, but continued in a consulting capacity his association with Lord Chetwynd as technical adviser to the British Mannesmann Tube Company. His wide knowledge and experience on the subject of the flow of metals proved of inestimable value.

When Ferranti became interested in radio matters in 1922, Mr. Hall turned to his new problems with the same zest and accuracy of approach as he had shown twenty years earlier in experiments upon the steam turbine. Radio, in fact, became the dominating interest of the remaining twenty years of his life, and since the death of Dr. Ferranti in 1930 the position he had held with Ferranti Ltd. was that of chief engineer to the radio department. In all the radio activities of the company he played a leading part from the design of the first audio-frequency transformer to the production of the latest receiving set. In 1931 he was responsible for the first commercial super heterodyne receiver made in England, and he contributed much to the perfection of the moving coil loudspeaker.

In the accident which resulted in Mr. Hall's death Mr. Gilbert Newbigging, one of his assistants, also lost his life, and Mr. A. Billings, a second assistant, received serious injuries.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

REFLOATING SUNKEN SHIPS

SIR,—In a note submitted to the Council of the Institution of Civil Engineers in 1908, the writer described a method by which sunken ships, if not in too deep water, could be refloated.

In that note it was pointed out that a stranded ship has often been a total loss because it was impossible to refloat her by the means tried, and that there are circumstances—such as when the hull is pierced by rocks—which make it impossible to raise her by means of mats and pumping, or by the use of compressed air. The then recent loss of "Montagu," it was contended, might have been avoided if a method which that wreck had suggested to the writer had been employed, this being the packing of air into the hold and other compartments by means of containers, such as the paraffin oil tins (kerosene tins), which, being non-returnable, were at that time to be found in abundance at every seaport, or at a small port could quickly be collected from inland towns. It was proposed, in the note, that stores of tins should be kept at seaports, soldered up, air-tight, in readiness for immediate use, and such stores, even if small, could be accumulated on a salvage vessel or its accompanying steamer, on the way to the scene of action. In the case of "Montagu," it was pointed out, there was ample time to collect and prepare the tins, even after attempts at raising her had been going on for some time.

It was explained that the tins would be packed in by divers, first against the deck above the hold or compartment. Their small size would make it possible to stow them in parts of the ship otherwise unavailable for the provision of buoyancy. The packing would go on until no more could be placed or pushed in.

The discussion in regard to the crushing of the tins by pressure of the water need not be followed, because the great number of valuable vessels now lying on sea beds, many at small depths, renders it worth while to make special displacers. It may, however, be mentioned that, without allowing for resistance of the tins to crushing, it was obvious that the loss of volume would not be serious at shallow depths, while it was concluded that the method would be effective down to a depth of some 62ft.

It may now be accepted that: (*a*) in general, timber of low specific weight would serve the purpose in many cases, either alone or as tipping the scale in favour of refloating when other means do not suffice; (*b*) in regard to the many vessels awaiting their refloating around our shores, it is obviously worth while to construct special displacers, which could be cylindrical in cases such that it will suffice to displace most of the water, or hexagonal when maximum displacement is called for. For the greater depths these displacers could, should it be found necessary, be given maximum displacement effect, with small addition to the weight, by using thin steel and filling them with compressed air, to prevent them from being crushed. This would only apply to the larger displacers placed in the holds or other large compartments, unless the maximum possible flotation were to be called for in the case of a ship at a considerable depth.

The note was accompanied by sketches showing simple tools which could be used for putting in the displacers—as through holes in the hull of a small vessel or, in the case of a large vessel, holes in an outer hull not accessible from within the ship. One tool resembles a bricklayer's hod, such as, to-day, might be used for small displacers, such as billets of wood.

Testimony to the merit of the writer's method is afforded by Patent No. 28,912, December 15th, 1913—Means for Raising Sunken Vessels, Col. A. R. M. Sankey, R.E. (Ret.), and Sanrainé Syndicate, Ltd. The reference on page 476 of THE ENGINEER, issue of November 13th, 1914, reads:—"To raise the ship, bales of silk cotton—generally known as 'kopek,' a vegetable product having a very low specific gravity—are placed in her holds by a diver as shown. [He hauls them down from a barge by means of a cable passing over the barge.] A modification is described in which a blanket made of 'kapok' and some water-tight material is arranged in the shape of a balloon, and after being attached to the side of the ship is inflated by the expulsion of the water from within the balloon.—*October 21st*, 1914."

The balloon idea, which is not attractive, is one apart from the use of internal water displacers, in regard to which the method described differs from that of the present writer in respect of the nature only of the displacer. Kapok is not to be found in

abundance except at a few seaports and warehouses, and it is too valuable a material to be kept in store and used for the purpose of raising sunken ships, in view of the availability of other materials, in the general case, and in regard to the present situation. The fate of the writer's proposal of 1908 was to be placed in the Institution Library.

Reginald Ryves.

PEACE AIMS

Sir,—Sir Ernest Benn's letter on "Peace Aims," which appeared in the issue of February 21st, has prompted me to the following reply.

Such a sweeping statement as Sir Ernest makes on the abhorrence of collectivism appears to call for more consideration. To condemn collectivism is virtually to bury one's head in the sand, for, as I see it, the modern world could not carry on without a great measure of co-operative action. Collectivism carried to the extreme that it has been in some countries and, since the outbreak of war, in this country is certainly abhorrent, but individualism carried to the same extreme would be equally undesirable.

Modern technical progress is dependent on collective action. It may be argued that outstanding discoveries or inventions have frequently been due to the efforts of one particular man or woman working non-co-operatively, but this, I believe, is seldom the case, for while they may not make use of the assistance of their contemporaries, they are dependent on the knowledge and experience of those who have preceded them, and perhaps even the assistance of contemporaries is enlisted either consciously or unconsciously, solely by exchange of opinion.

I cannot see how Sir Ernest Benn hopes to be able to enjoy such modern conveniences as the postal service, the railway service or the electrical supply service without a great degree of collectivism. The production of the journal in which his letter appeared is only made possible by the work of a number of people acting collectively. On the assumption that he desires the continuance of these facilities it would appear that collectivism on the part of the worker is to be countenanced with exemption for those who can afford it or otherwise obtain it. It is scarcely necessary to add that where a state of affairs such as the foregoing obtains there is an abrogation of moral responsibility and duty.

The suggestion that union in the case of the trade unions is a conspiracy on the part of a section against the whole is, I am afraid, a misrepresentation of the true facts. The reason that trade unionism gives rise to a conspiracy against the whole community is that another section is conspiring against either the trade unions or the whole community by means of exploitation.

Doubtless, equality of sense, experience, honesty or character does not exist between man and man or nation and nation; but, on the other hand, the possession of outstanding ability does not constitute a licence for the ill usage or oppression of those not so fortunately endowed, as has so often been the case. While equality for everyone in the four categories mentioned above is unobtainable, a great deal remains to be done as regards equality of opportunity and the providing of a square deal for all. An example of inequality of opportunity was cited in a recent editorial in The Engineer, namely, the debarring of engineers from obtaining sufficient information to enable them to take part in discovering a method of combating night bombing.

The idea of doing as little as public opinion will allow is one that has been tried in this country for a good part of the past nine centuries, with the result we know only too well to-day. A far higher ideal is that of the greatest happiness of the greatest number. To my mind, the root cause of all the trouble in the world to-day is an inability or unwillingness of all concerned to understand the full implications of moral responsibility and duty.

In conclusion I must add that my reading of the history of this country does not admit of me joining with Sir Ernest Benn in saying that we have enjoyed nine centuries of living together in peace. Instances to the contrary are the Wars of the Roses, the Civil War, the Jacobite Rebellions, &c.

Glasgow, March 2nd. R. Kennedy.

BUSINESS MEN AND CIVIL SERVICE

Sir,—I was greatly interested in your leader under the above head printed in your issue dated February 28th, and not a little intrigued by the reference to the statement attributed to Lord Cecil to the effect that "on the whole the record of business men in public administration was not good" in the last war.

If that is really Lord Cecil's view and belief, it is obvious he is no authority to make such a statement. You are perfectly correct in saying that the examples to the contrary are many. Mr. Lloyd George could disabuse the mind of Lord Cecil on this point and so could Lord Inverforth, and many others.

I quote the first paragraphs of an article I wrote for the *British Steelmaker* in September, 1936, three years before the outbreak of war:

> "Now that the need for raising this nation to the full-power standard of armed protection has become clearly vital, and the necessary measures are having their due meed of attention in responsible quarters, the appointment of a Director-General of Munitions Production recently calls to mind the state of emergency which had to be faced at a critical period of the Great War. It is questionable whether, at this time, all the work performed by all the departments of that mighty organisation—the Ministry of Munitions—in those years could be recorded by any one pen, but it was tremendously alive and efficient, and it is definitely in our favour nationally that we have that experience to guide us now. It will be timely and not out of place perhaps to recall the activities of a section of the Ministry of Munitions which undertook and carried out with remarkable success highly important work and duties to the State in the stress of the great emergency in 1917 . . ."

The reference, primarily, is to the Area Steel Allocation Committees which were created by the Ministry of Munitions in 1917 (I was Secretary of the North-West Area). It will be remembered that Area Committees of steel makers and re-rollers were formed to act in an advisory capacity to H.M. Steel Superintendents in connection, principally, with the allocation of steel supplies and obtaining urgent requirements of finished steel in certain defined classes for the prosecution of the war.

It was not a question then of the business man bending to the will of the Civil Service permanent administration, because the industrialists appointed to administer the six areas in the respect named chose their own staffs and personnel generally, and these officers and staffs held temporary status within the establishment.

If the same procedure had been adopted on this occasion there would have been, I am confident, less need for Lord Perry's rapier thrust at parasitic officialdom. S. G. Throssell.

Manchester, March 3rd.

SCIENCE AND SECRECY

Sir,—In your Leader this week, dealing with the address of Dr. A. V. Hill to the Parliamentary and Scientific Committee of the House of Commons, you suggest that the leading institutions be asked to nominate members for the proposed advisory councils.

This raises a matter of fundamental importance in a world which is now realising the necessity for co-ordination in our present-day vast activities. The new world that we look forward to will require major modifications in our national machinery, and the one we, as engineers, are concerned with is linked with the subject of Dr. Hill's address.

Your suggestion to link up the institutions with Government Departments will probably prove to be the most practical method of filling the gap that is still sadly vacant in our national planning and executive methods. The great need in our post-war planning will be co-ordination, but how are we to have this with the highest efficiency unless we have some form of permanent machinery to directly link the political executive with the scientific and operating machinery of our industrial life?

Purley, February 21st. John D. Troup.

THE USE OF THE WORD "ACCURACY"

Sir,—The word "accuracy" is very frequently used in relation to engineering practice. One can seldom open an engineering journal without coming across such phrases as "limits of accuracy," "degrees of accuracy," and so on. In view of its wide use it would appear important that it should be used correctly.

In the majority of cases, however, the word seems to be misused. Accuracy indicates perfection; it is an absolute rather than a relative state, and consequently can have neither "limits" nor "degrees."

Unless we are to admit such expressions as having become idiomatic due to long usage, I suggest that a better way would be to use instead the word "inaccuracy" with, in certain cases, the qualifying word used antithetically. Those well-worn expressions "limits of accuracy" and "degrees of accuracy" would then become "limits of inaccuracy" and "degrees of inaccuracy." "A low degree of accuracy" would be changed to "a high degree of inaccuracy," or, better still, the purist might suggest dropping the word altogether (as there can never be accuracy in engineering practice), and referring to "limits of proximity" or "limits of error."

Harry Walker, Ph.D.

Rochdale, February 19th.

THE NICHOLSON SIPHON

Sir,—In your issue of February 28th it is stated that the new L.N.E.R. engine is the first locomotive on a British railway to be fitted with a Nicholson thermic siphon.

I would point out that the first Nicholson thermic siphon was fitted to a locomotive on the L. and N.W. Railway in 1922. Eric A. Robinson,

Managing Director.

The Superheater Company, Ltd.,

Sixty Years Ago

Steel versus Iron

Although steel was being employed to a considerable extent sixty years ago in the construction of liners—such as the "Servia," mentioned in last week's note—and of warships, justifiable doubt continued to exist in its trustworthiness. The Bessemer and the Siemens-Martin processes were in close rivalry, but it was slowly becoming recognised that Bessemer steel was not suitable for the construction of ships and boilers. The Marine Department of the Board of Trade, according to a leading article in our issue of March 11th, 1881, had been experimenting for some time with steel plates and had recently issued a memorandum on the subject for the information of its surveyors. It would appear that the experiments were of a very restricted nature, and left many vital points as vague as ever. Such as they were, however, they constituted, we said, a blow to the Bessemer interests, and a very considerable boon to manufacturers using the Siemens-Martin process. They were initiated at the request of the Steel Company of Scotland, which had been established in 1872 to operate the Siemens-Martin process and which was rapidly expanding its works towards an output of nearly 150,000 tons a year. Steel plates made by the Scottish company were alone tested by the Board of Trade. The strengths and ductilities registered were of a good order, but comparative tests of Bessemer steel or of Siemens-Martin steel made by other firms were not carried out, with the result that the Board's findings could be held to be applicable only to the products of one particular firm. The question of the ductility of steel was all-important at that time, because it was believed that much of the reported untrustworthiness of steel could be traced to an erratic variation in its ductility leading to brittleness and low resistance to shock. The Board of Trade memorandum expressed the view that the increased or even continued use of steel in shipbuilding and boilermaking would be largely dependent upon the manufacturers, and that competition between them might have the result of reducing the ductility of the material. For the tests the Steel Company of Scotland submitted plates ⅛in., ¼in., ⅜in., and 1in. thick. It was found that the thinner the plate the better was its elastic limit, and the higher its breaking stress, although the ultimate extension increased with the thickness. Another subject on which disquiet was felt over the use of steel plates in shipbuilding and boilermaking was the effect of punching holes in them. It was generally believed that punching had a bad effect on the strength of steel plates and that it induced local brittleness. The Board of Trade experiments fully supported this view. It was found that the ultimate strength of punched plates was noticeably less than that of unpunched plates, and that as the thickness of the plates increased the harmful effect became greater. While we can readily accept this result as accurate, we find a certain difficulty in believing the general truth of another result recorded in the memorandum, namely, that the ultimate stress of a drilled plate was actually greater than of an undrilled plate, the gain in some cases examined being as much as 13 per cent.

The Late Mr. W. T. Morgan.—We learn with regret from the Taylor Instrument Companies, of Rochester, N.Y., of the sudden death of Mr. William Trefor Morgan, chief metallurgist. Mr. Morgan was born in 1895 at Swansea, Wales. He attended the Swansea Technical College and Sheffield University, where he studied under Professor C. H. Desch. His academic career was interrupted by the first World War, in which he served five years, four of them on active service in France, Egypt, and Palestine. After the war he was associated with R. D. Thomas and Co., Ltd., steel and tin-plate manufacturers of Swansea, and later joined the Scientific Research Department of the Admiralty, where he spent six years. After migrating to the United States, he was associated with Babcock and Wilcox, of Bayonne, N.J., and in 1929 he joined the Taylor Instrument Companies, assuming charge of the metallurgical laboratory. Mr. Morgan was a member of the American Institute of Mining and Metallurgical Engineers, the Iron and Steel Institute of Great Britain, and the American Welding Society, and was a Past-Chairman of the Rochester Chapter of the American Society for Metals.

Avoidance of Bottle-Necks in Production

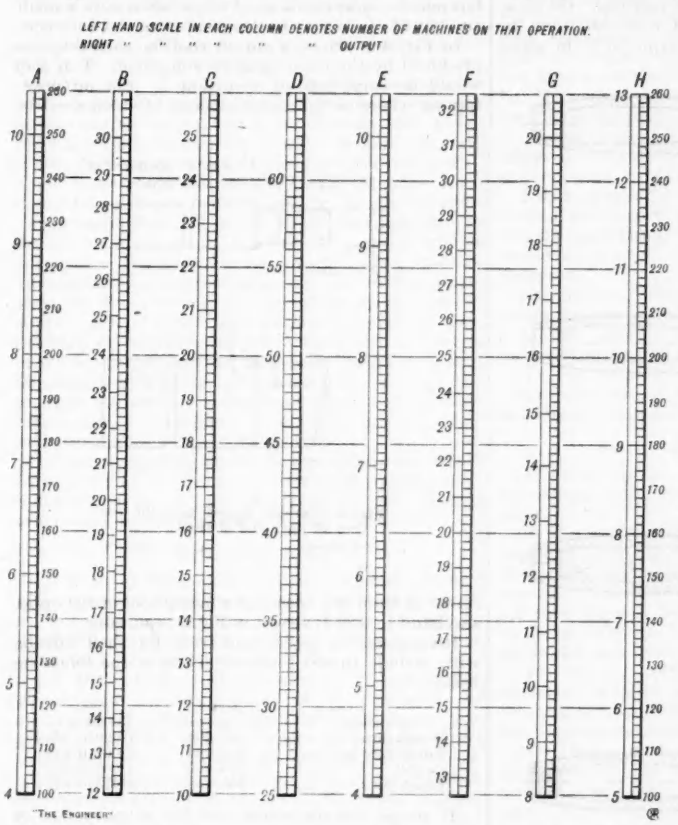
(*Contributed*)

NO one doubts that the only way in which munitions of war, or indeed, articles of any kind can be produced in the maximum quantities by semi-skilled labour is by subdividing the whole manufacturing process into a large number of simple operations, each performed by its own group of workmen. But to carry out such a procedure effectively calls for extreme care in securing a steady flow of work through the shops, otherwise it is impossible for the whole organisation to be kept working at its maximum capacity. The fact that the operations are performed in series has the consequence that a lessened output at any stage of manufacture creates a congestion of material at the preceding stages and a starvation at subsequent ones, so that even a minor hitch at any point affects the whole production of the works. Whatever the trouble may be due to, whether oversized forgings or castings, defective material, breakdowns of machinery, absence of operators through sickness, or any of the thousand and one other things that hinder production, no department can suffer without the effect being felt in every other department working in series with it. The art of good management is to detect such "bottle-necks" immediately they occur, and to remedy them with all speed.

Now, a mere supervision of the operators and their machines is not in general sufficient to discover the trouble before it has become serious enough to result in actual idleness or to give rise to complaint. The workmen whose output is not being absorbed as rapidly as it should, equally with those who are receiving an inadequate supply of work, will naturally tend to adjust their pace to the slackened flow of material. They are not to be blamed for this, for they are properly reluctant to say anything that may inculpate another department, and they prefer to work slowly rather than to have nothing to do for part of the time. The consequence is that a situation calling for correction may endure possibly for a number of shifts before a falling-off in the output of finished material brings definitely to the notice of the management the fact that all is not as it should be.

The possible causes of a lessened output on some particular operation of a series are so numerous that no amount of care and foresight can always ensure that perfect regularity in the flow of work which is so desirable for efficiency. Every factory will have its own particular problems, and must devise its own methods of dealing with them. The really important thing is to have some means of becoming aware of any hitch as soon as it occurs, and to be able to make immediately the adjustments that the situation demands. The need for maintaining the maximum output during the last war led to a system of discovering and dealing with bottle-necks which proved as effective as it was simple. This will be described, in the hope that it may prove useful or at least suggestive to engineers concerned with similar problems to-day.

The department was organised for the output of 200 articles per shift, but it was in a state of continual expansion on account of the insatiable demand for its products. During the course of manufacture, the material was subjected to twelve separate machining operations in series, each performed by its own group of workers. The first step towards control was to prepare a chart consisting of twelve separate columns, one for each of the operations in question. All the columns were similar, each having the appearance of a ladder with equal graduations denoting the output per shift on that operation. At the end of every shift the actual outputs attained were marked by movable red-headed pins, one, of course, in each column. All the pins would have been in a straight line horizontally across the chart had the flow of work been perfect at the particular level of output shown. Actually, the line was always more or less wavy. The deductions to be drawn were obvious. Suppose, for example, that the pin showing the output on operation C was in the trough of a wave. This indicated that on the next shift the following operation D would be starved of work, subject, of course, to any alleviation due to a previous accumulation of stock between C and D. Although a reasonable accumulation was permitted by the management as a sort of useful buffer between operations, this hardly affects the main question. The stock would obviously have to be made good at some time, so that its effect could be neglected. As a general rule, all operations subsequent to C would suffer sooner or later in output, as a consequence of the defection of C, until the effect reached the final result of restricting the delivery of finished work into store, perhaps several days later.



OUTPUT CHART

Alternatively, it may be supposed that the output of operation C was on the crest of a wave, and therefore above the normal. There was no real satisfaction to be obtained from this, for although the workers on that operation might be deserving of praise, the result, from the point of view of the management merely indicated a temporarily excessive productive capacity which might well be transferred to where it was more wanted. It would certainly have been wrong to allow C to continue its high output shift after shift, even supposing material could be fed to it in sufficient quantity, for such a procedure would only cause congestion in later operations. It would have been even more wrong to discourage the workers from doing their best or to fail to supply them with adequate material to work on. The correct course was therefore to diminish the operating strength of C, and to increase that of such sections as were shown by the curve to need it.

In order to facilitate the control of operating strength, another column denoting the number of machines in service was drawn adjacent to each of the output columns on the chart. It may be mentioned that the number of machines did not always correspond with the number of workers, for in some cases a worker attended to more than one machine. The calibration of the machine scales was done in the following way:—Opposite the standard output of 200 per shift, on each column was marked the number of machines considered to be necessary for that output, and the remainder of the machine scale was then calibrated proportionally. The appearance of the chart was then as seen in the figure, in which, however, only eight operations are shown in order to save space.

Besides the red-headed pins already mentioned, there were green-headed pins which were used to mark the number of machines in service on each operation during the shift. In the ideal case, both red and green pins would have been in the same horizontal line. But if machines were down for repairs, or were idle owing to the absence of operators, the corresponding green pins would be below the normal positions, while if extra machines had been brought into service to cope with hardness of material, outsize forgings, or other cause, the corresponding green pins would then be above the normal.

The practical use of the chart hardly needs explanation. If, for example, the output on any operation is down as shown by the red pins, and the corresponding green pins show that there is no shortage of machine power, the conclusion is either that the material is exceptionally difficult to work, that some of the operators are not sufficiently skilful, or that the work is not coming to them fast enough. The last supposition can be confirmed or dismissed by the information given by the output curve of the previous shift. If, on the other hand, it is considered that extra machines are needed temporarily to cope with the situation, these are best transferred from some operation in which the red pin is at the top of a wave.

Many critics will question the practicability of suddenly changing over semi-skilled workers and their machines from one operation to another. With regard to workers, the difficulty need not be great. There is indeed no trouble at all if a few of those normally engaged on one operation have also been trained to perform other simple processes. Moreover, even when not previously trained, the most intelligent and ambitious of them will be glad to try their hands at something else, and will pick up a new operation with comparative ease.

The possibility of changing over machines is subject to obvious restrictions. It is not suggested that a lathe can be made to do the work of a punching machine or that a drill can be used as a slotter. But any machine of a standard type is wonderfully adaptable to different kinds of work within its range. In the factory, where the scheme was introduced, almost all the operations were performed on lathes, fitted up with appropriate chucks, work-holders, tools, &c. Whenever extra machine power was wanted on an operation it was not a great matter to change over chucks, jigs, and other equipment to suit the new duties. It could, indeed, usually be done between shifts or in the dinner hour. The decision as to what particular machines should be changed over was determined by looking at a large-scale plan of the shops which hung alongside the chart on the wall of the manager's office. On this plan the position of every machine was marked by a rectangle, and on each rectangle was pinned a small card of distinctive colour, indicating the particular operation on which the machine was engaged, viz., red for rough turning, blue for boring, and so on. One could then see at a glance how each was occupied and decide which could be most conveniently changed over to suit the general flow of work through the shops. The coloured cards were, of course, changed at the same time as the machines were converted, so that the plan always showed the various operational groups correctly.

It is not pretended that the system described would be applicable to all classes of manufacturing, or to all factory organisations, but the principle underlying it is considered to be a sound one, and it has certainly proved its value in the control of a large undertaking.

SWEDISH SHIPBUILDING.—In order to make good lost tonnage, the Svenska Lloyd has placed a further order for a 2900-ton freighter with Lindholmen's shipyard at Gothenburg. She will be a sister ship to the motor vessels "Venezia" and "Industria," which that shipyard has previously delivered to the Svenska Lloyd. Two motor vessels of the same type were ordered from the same yard last May and another is under construction. The Stockholms Rederi-a.b. Svea has ordered a motor tanker of about 16,000 tons deadweight from Kockums mek. Verkstad, Malmo. The vessel will be of all-welded construction, and will be fitted with an eight-cylinder, two-cycle, double-acting Kockum-M.A.N. diesel engine of 6000 H.P.

Machining British Shells in Canada*

ALTHOUGH British shells differ somewhat in design from American shells, the sequence of machine operations is much the same. A review of present machine practice as carried on in Canadian plants should therefore be of help to American manufacturers who are faced with the problem of tooling up for shell production. Canadian practice is summarised in the operation sheet, Fig. 1 on this page.

The main difference between the British and the American shell lies in the method of attaching the reinforcing plate at the base of the shell. In the former, operation 8, the plate is set in a recess, the lip of which is peened over, whereas in American shells the plate is attached by a resistance welding process. This design somewhat simplifies the machining operations on the latter.

Another variation in machining practice depends upon whether the forging is made by the pierce and draw method or in an upset forging machine. In the former case British practice is to turn an irregular contour on the nose end of the shell in the rough turning operations (2) so as to reduce the amount of stock to be removed from the inside of the shell after the nosing operation. In the latter case a taper is formed in the nose end of the cavity during the forging process. This taper accomplishes the same purpose and at the same time simplifies the rough turning. American practice, on the other hand, is to rough turn the shell to a cylindrical form regardless of the type of forging, except on the larger sizes of shell. This procedure simplifies the rough turning, but means that a greater amount of stock must be removed from the cavity in a subsequent operation.

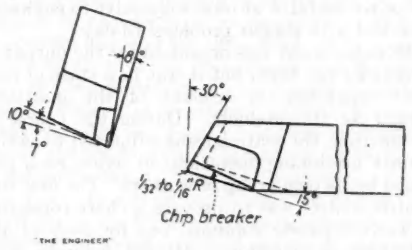
Still another difference between the American and the British shell is in the design of the band seat. The American shell has a knurled surface, whereas the British shell has three sharp ridges of sinuous or wave form in the bottom of the groove and extending circumferentially around the shell.

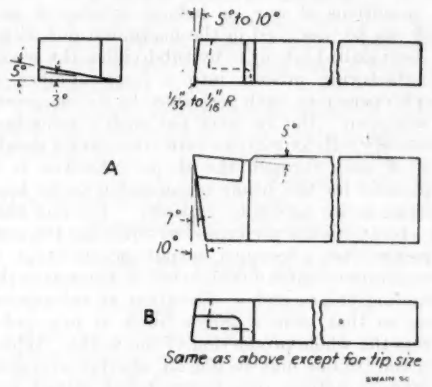
* *The Iron Age*, January 9th, 1941.

A feature of shell forged in an upsetter is that the open end of the shell is closely held as to length, leaving but a relatively small amount of stock which can be faced off, instead of making it necessary to employ a cut-off tool in the rough turning set-up, as is the case when the pierce and draw method of forging is used. A carbide cut-off tool is quite satisfactory, but usually does not have as long a life as a simple carbide facing tool used on upset forgings. On some machines the life of the cut-off tool can often be improved by stopping the tool $^1/_{64}$in. to $^1/_{32}$in. away from the axis of the shell. The excess material can then readily be removed by knocking it off with a hammer after the shell has been taken out of the lathe.

(BELOW)
Fig. 2—Carbide tipped tool for rough or finish turning shell

(AT RIGHT)
Fig. 3—Carbide tipped tool for facing base end of shell





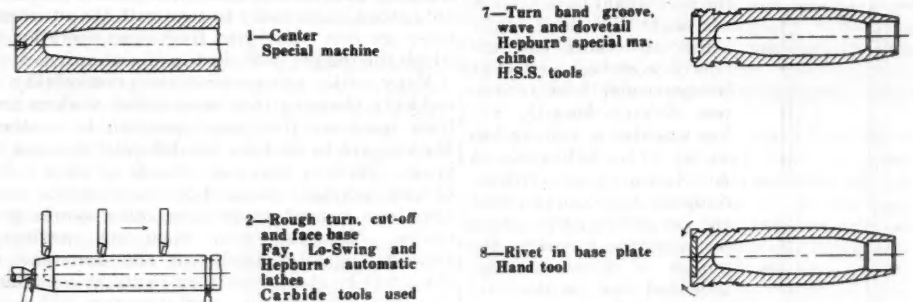


FIG. 1—OPERATION SHEET FOR BRITISH SHELL PRODUCTION

TOOL DESIGN

Tools for turning shell can readily be made from standard carbide tools except for large shells where the cuts are extremely heavy or the forgings are markedly excentric. For these conditions the tools require carbide tips 25 to 50 per cent. thicker than are used on standard tools.

For both rough and finish turning the carbide tool design shown in Fig. 2 is suitable. This tool is an adaptation of a Carboloy style 13 standard tool.

For facing the base end the tool designs shown in Fig. 3 are applicable. Tool A can be made from a Carboloy style 1 standard tool, while tool B is special, but may be more economical to use when only a small amount of stock is to be removed from the base end.

In Fig. 4 is shown a cut-off tool for shell forgings produced by the pierce and draw method. This tool would be employed on operation 2. For an upset forging where only a small amount of stock need be removed from the open end a facing tool of the opposite hand to tool B shown in Fig. 3 is suitable.

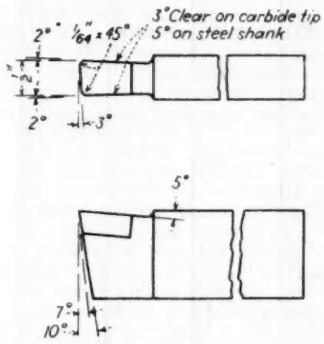


Fig. 4—Carbide tipped tool for cutting off open end of shell.
"THE ENGINEER" SWAIN SC

Recommended speeds and feeds for shell turning with carbide tipped tools are listed in the following table :—

Operation.	Speed, Ft. per min.	Feed, In. per rev.
Rough turn	250–300	0·020–0·025
Rough face base end ...	250–300	0·007–0·012
Cut-off	250–300	0·007–0·012
Finish turn	300–350	0·015–0·025

To obtain the maximum tool life, a heavy flow of coolant should be used on both the rough turning and finish turning operations. A soluble oil emulsion has been found to be the most satisfactory coolant for use with carbide tools when cutting steel.

RENOVATING USED FILES.—In these present times when economy in all things is essential to the national war effort, any process whereby files can be given a new lease of life must command attention. From the Az-New File Company, of 365, West Green Road, Tottenham, London, N.15, we have received two sample files reconditioned by its process. That process involves treatment of the used files in an acid bath, but does not necessitate the heating of the files, and therefore does not destroy their temper. The effect of the process would appear to be a genuine sharpening of the file teeth. One of the files submitted to us has been treated over only half its length, in order that we may compare the original worn texture with the reconditioned. The reconditioned portion is the half farthest from the tang, the portion which is generally the worst worn. It is noteworthy that the process does more than remove the rust from the file and the swarf and dirt clogging the teeth. The teeth of the treated portion feel sharp to the fingers and appear sharp under magnification. Tested on mild steel, the difference in the cutting action when passing from the treated to the untreated portion is very marked. Without a prolonged and carefully controlled test, it is impossible for us to state what would be the average length of the new lease of life imparted to the files treated by the process. We would hardly expect it to be as long as the original life of the file, but even if it were only half as much, the process in these times would certainly justify itself. We understand that for one London firm alone the company has reconditioned over 3000 assorted files, and that they have given satisfaction. The process is applicable to all types and sizes of file, round and half round as well as flat, and also to filing wheels.

Contract Terms in Common Use*

THE term "contract" here refers to contracts made by Government Departments in connection with wartime expenditure.

I. TENDERS

(1) *Competitive Tender† for Contracts:* (a) *Open or Full Competition.*—A system in which opportunity is given by a Government Department to all firms in a trade or industry to tender for a contract subject to specifications laid down by the Department concerned.

Fully competitive tender requires the public advertisement of the general requirements involved in the contract and of its terms and conditions. This makes inevitable a certain delay before work can be put in hand, for time must be allowed for firms to inquire about specifications and to prepare their estimates; and subsequently a large number of tenders may have to be examined. The system is therefore incompatible with a need for rapid expansion of output, and is not used by the Defence Departments for armament supplies in present circumstances.

(b) *Limited Competition.*—In practice, the term "competitive tender" is applied to the system where only firms on an approved list are invited to tender, even if only two or three such firms are so invited.

This is a limited form of competition and is so regarded by certain Departments, though not by all. It should be differentiated from fully competitive tender by public advertisement.

Acceptance of tenders is normally based on the price quoted for work; but other factors, which in some circumstances may be predominant, are rate of delivery, date of commencement of delivery, and ability to comply with the specifications required.

(2) *Non-competitive Tender for Contracts.*—Non-competitive tender exists where a Government Department does not invite more than one firm to tender for a contract. Contracts are placed in this way where Departments are satisfied that effective competition is not practicable, *e.g.*, where it is necessary for the Government to use a whole field of supply, and also in many cases of specialised, proprietary, or experimental products, as well as in cases of extreme urgency. In such cases the price should be checked by costing (see below), unless the Department is satisfied by a certificate from a responsible officer that on technical or other grounds it is fair and reasonable, and can be accepted.

In an emergency, contracts are sometimes placed by securing all the available or suitable capacity in an industry through trade representatives who allocate orders and usually negotiate standard prices.

II. COSTS AND COSTINGS

(3) *Costs of Production.*—All the expenses, of any kind, necessarily incurred (or to be incurred) in carrying out a specific contract. These total costs may be divided into two groups, namely, (*a*) direct or prime costs, and (*b*) overhead costs.

(*a*) *Direct Costs.*—Those costs which are immediately and directly incurred in the production of specific quantities of goods, and attributable to those goods alone, *e.g.*, the materials and labour used exclusively in the making of those goods and no others.

Prime Costs.—Prime costs are strictly synonymous with direct costs as defined above. But in the building trade the term is frequently used more loosely, and may include a varying proportion of overhead costs which will be specified in the contract.

(b) *Overhead or Indirect Costs, or Oncosts, or Establishment Charges.*—The general expenses of maintaining a productive establishment which are not wholly or directly attributable to the production of any specific quantity of goods.

Overhead costs will normally include, *e.g.*, the cost of managerial and clerical staff (possibly some supervisory staff), maintenance and depreciation of plant, &c.

The calculation of overhead costs on a particular contract involves the allocation of the proportion of overheads which is appropriate to that contract; this requires the expert judgment of the accountant.

The method of assessment of overheads varies, and the Government cost accountants in some cases accept the firm's practice. It is often found convenient to divide overhead expenses into two sections, "shop oncosts" and "general overheads." This allows of the adoption of different rates of oncost for the different sections of the factory, in each of which the processes may involve charges bearing no relation to the others. The "general overheads" include items such as selling expenses, managerial and supervisory staff, which are common to the whole organisation.

NOTE.—(1) In the case of a factory or plant which is engaged upon one single product, *e.g.*, shell bodies of a certain size, and no other, the allocation of the costs attributable to that product is simple, and for this reason it may be convenient to treat as direct costs items which would have to be regarded as overheads by a firm with a heterogeneous output.

NOTE.—(2) It is common to speak of the costs of production of any particular batch of goods; but in some Departments the term "batch" is reserved for those portions of output in respect of which separate contract arrangements are made, *e.g.*, the "educational" first batch in the production of aircraft.

(4) *Cost Investigation or Examination.*—A general term for the inquiry into costs of production by one or other process of costing.

(5) *Costing.*—Costing means the calculation or assessment of costs of production. It is of two kinds:

(*a*) Technical costing or cost estimation; and
(*b*) Post costing or cost ascertainment.

In practice, the term "costing" is more commonly applied to post costing, and some business men maintain that this is its only proper sense. For this reason it is probably undesirable to use the term without qualification.

(a) *Technical Costing or Cost Estimation.*—The estimation of the costs likely to be incurred in production which has not begun or is in its early stages.

As far as direct costs are concerned, this is a task for technical experts, *e.g.*, ratefixers, who are familiar with the details of methods of production in the industry concerned, and can decide what material and labour are necessary at each stage of production, but the correct allocation of overhead costs is a task for the accountant.

(b) *Post Costing or Cost Ascertainment.*—The calculation of the costs which have actually been incurred in production, which has been completed.

This is a task for the accountant. The ascertainment of direct costs is concerned with matters of fact, but the ascertainment of overhead costs is to some extent a matter of opinion and requires expert judgment.

(6) *Estimated Costs.*—The costs of production of a particular output which is contemplated, and for which the costs have been estimated on the basis of technical costing as described above.

(7) *Ascertained Costs.*—The costs of production of a particular output which has been completed, calculated by the process of post costing, as described above.

III. CAPITAL

(8) *Fixed Capital.*—The capital invested in a firm's permanent equipment, including land, buildings, and plant.

(9) *Working Capital.*—Capital used by a firm in the course of production, in order to purchase material, pay wages, and meet current overhead costs. The amount of working capital necessary depends upon the time elapsing before payment for the product is made, and may be considerably reduced by a system of interim payments or advances.

(10) *Capital Employed in a Contract.*—Capital employed includes both the working capital used on the contract, and also the proportion of the firm's fixed capital devoted to the work in question.

(11) *Depreciation.*—The annual fall in the value of capital equipment as the result of wear and tear, normal obsolescence, &c. The term is frequently used in a more special sense as referring to the specific rates of depreciation allowed by the Inland Revenue authorities in tax assessments. These rates are based on the period during which the equipment or plant can be expected to continue to contribute to revenue; special rates are allowed where plant is used intensively under a multiple shift system.

(12) *Amortisation of Capital.*—Amortisation is provision for the replacement of capital expended on equipment or plant. The allowance made under the heading of Depreciation is intended to cover normal obsolescence, but under conditions when an urgent need for expansion of output has led to the acquisition of capital equipment which may become redundant before its working life is complete, a special additional allowance may be made or claimed, either in the contract price or by a direct Government contribution towards the capital cost.

IV. PROFIT

(13) *Profits.*—Profits are the difference between selling price and total costs of production.

When a fixed price is set for a contract, profits are the residue remaining after the contractor has met the costs actually incurred (whatever they may prove to be) out of the fixed price; and in any individual case it is possible for the result to be negative—that is, for costs to prove greater than contract price—when loss ensues.

In all the forms of contract, however, which provide that the total payment to the contractor shall be adjusted after production is completed, according to the ascertained costs of production, the margin between this total payment and costs may be defined, directly or indirectly, in the contract. The contract may state directly that the margin between costs and total payment shall be a certain sum, or, because of the difficulty of fixing this sum while the other quantities are still unknown, may define the margin by reference to a rate or percentage of profit or to what the Department considers fair and reasonable.

(14) *Rate or Percentage of Profit.*—Rate or percentage of profit is the proportion which profit may be conceived to bear to some specified sum.

It is unfortunate that there is no complete agreement either in economic theory or in business practice as to the sum of which, or on which, profit should be taken as a percentage.

On the one hand, there is sufficient similarity between profits and interest on capital to indicate that a comparison between them may be made—it being understood that the risk element which is inseparable from profits gives rise to a legitimate expectation of a higher percentage return on capital. This way of regarding the rate of profit is encouraged under modern conditions by the prevalence of the joint stock company, whose dividends on ordinary shares give expression to a rate of profit which may be compared with rates of interest on Government bonds.

On the other hand, it has long been the habit of most business men to reckon their profits as a percentage of their costs, and over a period this means that profits are regarded as a percentage of turnover. The greatest advantage of this method is its simplicity, for it makes it possible to reckon the rate of profit on a particular contract, or on a particular branch of the enterprise simply by reference to the amount received, and without deciding what proportion of the firm's total capital was employed in the work in question.

At first sight it would therefore appear advantageous to accept the latter usage in Government contracts, on account of its simplicity and familiarity to business men. The main objection is that a fixed rate of profit on costs will give an inordinately high return on capital if turnover is rapidly increased, and the percentage return on capital employed may be out of all proportion to the general level of investment.

It is therefore essential that, if any percentage of profit which may be the basis of a contract is for convenience applied to costs, it should be made to vary in such a manner that the percentage return on capital employed does not increase fully in proportion to increase of turnover.

In this connection, the following considerations should also be taken into account:—

(i) Any capital assistance given by the Government reduces the capital of the contractor necessary for the contract, and the profit should, of course, be related to the return on the contractor's capital employed.

(ii) The amount of capital employed by the contractor may be considerably reduced by a high proportion of sub-contracting.

(iii) The rate of return on capital should bear some relation to the degree of risk borne by the contractor. If the form of contract reduces the risk of loss below the normal commercial level in the trade, a lower return on capital appears justifiable.

V. TYPES OF CONTRACT

(15) *Running Contract or Term Contract.*—A contract providing for the supply of a commodity over a specified period (usually a long period) within which the buyer may from time to time order quantities of the commodity on the terms laid down in the contract. The contract contains a specification of the commodity, but does not state the quantity to be supplied at any particular time.

(16) *Agency Agreement.*—An agency agreement may provide for the employment of a particular firm, either:—

(i) To erect and manage a State-owned factory, or

(ii) To provide additional manufacturing capacity at the Government expense, to be the property of the Government, but to be operated by the firm as contractors.

(17) *Agency Contract.*—This term is sometimes applied to a contract for production made with a firm which is operating a State-owned factory or with State-owned plant, under a previous Agency Agreement (as described above).

(18) *Sub-Contract.*—A contract made by the main contractor with another firm for the supply of a finished product, or for the processing of a product, or for a service (such as cartage), which is a part or component of the subject of the main contract.

The term "sub-contract" should not be applied to the main contractor's purchases of materials for the work of his own firm; nevertheless, it is sometimes so applied by certain Departments.

(19) *Fixed Price Contract.*—A contract for a specific output at a price which should be fixed before production begins or at a very early stage in production.

The price may be fixed in terms of units of output or as a total which will cover the whole output. So long as the output concerned is specified, this distinction is unimportant.

The important point in such contracts is that the fixed price will not be subject to adjustment after production is completed. The risk of costs increasing during production, so that profits are reduced to a low level or wholly obliterated, falls upon the contractor, but, on the other hand, the contractor will

*From the Fourth Report of the Select Committee on National Expenditure. H.M. Stationery Office. Price 9d.

†The term "competitive contract" is a loose usage, since the competitive element lies in the tender and not in the contract.

reap the full benefit of any reduction of costs below the level anticipated when the contract was made. (See, however, Variation Clauses, below.)

(20) *Lump Sum Contract.*—A contract in which a total price is fixed to cover the whole of a specified output.

There is no difference in kind between this form and the Fixed Price contract, but the term "lump sum contract" is usually applied to a contract which concerns building construction, *e.g.*, a camp or factory unit.

(21) *Bills of Quantities.*—Lists of the items of completed work required to make up a finished building, prepared by quantity surveyors from the drawings. The lists are subdivided so that each contractor invited to tender can be presented in convenient form with a complete bill of the quantities of work of each main type. In preparing his tender for a lump sum contract, the prospective contractor prices each item in the bill, and the total of all the items becomes his tender for the execution of the work as a whole. The principal factors contributing to the price of each item include cost of labour, cost of material, use of plant and transport, overheads, and profit.

Considerable skill and experience are required on the part of the estimator. If the construction is varied, it is necessary to measure the variations, and these are valued on the basis of the prices inserted in the bills for comparable items.

(22) *Schedule of Prices or of Rates.*—A list of items of work, prepared similarly to a bill of quantities (see above), but without reference to the actual quantities required. In consequence, if a schedule of prices is used as the basis of a contract, it is necessary to measure fully the whole of the work actually carried out, valuing each item at the price in the schedule.

Tender for such a contract can be arranged in two ways :—

(*a*) The schedule can be issued without prices and the prospective contractor asked to insert prices : or

(*b*) The schedule can be priced before issue and the prospective contractor asked to quote a percentage above or below the listed prices as a whole.

(23) *Maximum Price Contract or Limiting Price Contract.*—A contract in which a maximum price, which includes both cost and profit, is set before production, and the contractor is paid the costs actually ascertained by post costing plus an agreed profit, subject to the maximum price not being exceeded.

The contractor is not paid any proportion of a saving on the maximum price. In some cases, however, a maximum price contract may also provide a target price (for definition, see below), which is independent of, and usually below, the maximum price, and a proportion of any saving on the target figure is paid to the contractor. It is the practice of the Ministry of Supply, where this arrangement is most frequently found, that the target should never be higher than the maximum price minus the agreed profit.

(24) *Target Cost or Target Price Contract.*—In this form of contract a standard or basic figure is agreed before production (or at an early stage in production), and the contract provides that if the costs ascertained by post costing are below this target figure, the contractor is paid, in addition to the ascertained costs and the agreed profit, a share of the difference between ascertained cost and the target figure (*i.e.*, saving), so long as this saving is due to the contractor's own efforts.

The object of this form of contract is to offer a direct financial incentive‡ to economical production, while still permitting the adjustment of terms after production which may be necessary in the case of a new type of output.

Where the ascertained costs are in excess of the target figure, the practice varies. In some Government contracts, costs in excess of the target figure have been paid in full without any precise limit being set and without any reduction of the agreed profit, but in these cases the fundamental principle of the target system has been neglected. Such contracts cannot properly be termed target cost contracts, and are more correctly grouped with "cost plus" contracts (see below).

In the practice strictly compatible with this type of contract, a precise limit is set to any payment of costs in excess of the target figure, and such payment is either reduced to a mere proportion of the excess costs or is accompanied by a reduction of the payment on account of profit. In some cases a fraction of the excess costs may be paid up to a certain percentage of excess, after which all such payment ceases ; in others, a maximum may be fixed independently of, and slightly above, the target figure. Only by such measures can the fundamental principle of the target type of contract be made effective.

(25) *Target Measurement Contract.*—This form of target is based on measurements (according to a schedule of prices) of material and labour used, and therefore the target figure cannot be calculated as a definite sum until completion of the work. It has been used by the War Office in certain contracts for camps, and has given rise to many complaints that the contractor cannot know in advance whether or not he is likely to earn a bonus for saving on the target cost.

The advisability of applying the term "target" to any but a specific and determinate sum, at which (or, strictly, below which) the contractor may aim during production, is extremely doubtful.

(26) "*Cost Plus*" *and* "*Time and Lime*" *Contract.*—This form of contract is sometimes called "Time and Materials" or—inaccurately—"Time and *Lime.*" It is one in which the contractor is paid the ascertained costs of production together with an agreed profit, without any attempt to arrive at a fixed price before production, or to limit payments by reference to a target or a maximum price.

The agreed profit, which is paid in addition to ascertained costs, may be a fixed sum, but frequently in this type of contract it has been expressed as a percentage of ascertained costs. In general, the term "cost plus" may be understood to imply "cost plus a percentage of costs," unless it is stated that the profit is otherwise calculated, and in a "Time and Lime" contract the profit is always a percentage of costs.

Cost plus a fixed profit cannot be considered as a fixed price contract, though it is sometimes referred to as such.

VI. Special Clauses

(27) *Variation Clauses* ("*Rise and Fall*" *Clauses*).—Clauses inserted in contracts which provide that in the event of certain alterations in costs which are outside the contractor's control there shall be adjustment of the payments made to him. Changes in rates of wages and prices of materials are commonly specified in such clauses.

The insertion of such clauses may completely alter the character of a contract. A fixed price contract or a maximum price contract may, by the introduction of a variation clause, be reduced to the level of a cost plus contract, and it is possible to remove a large part of the incentive to economy from a target price contract by the same means.

(28) *Break Clause.*—A clause which permits the contract to be determined by the buyer and defines the extent to which the contractor is entitled to indemnity for work in hand and for liabilities legitimately incurred if this power is exercised.

Such a clause is naturally most common in contracts continuing over a long period, and in general will not be found in contracts which do not cover a period of at least six months.

‡ The imposition of 100 per cent. Excess Profits Tax may remove the direct financial incentive to economical production from a target price contract, and even from a fixed price contract, if the contractor has sufficient other business to obtain the level of profit free of tax (*i.e.*, his "standard" rate) without an improvement in efficiency.

The Suspended Matter in the Nile*

Introduction.—When in flood the Atbara and the Blue Nile annually bring down in suspension large quantities of silt from the Abyssinian plateau. The deposition of this silt has from time immemorial formed and is still forming the fertile land of Egypt. The earliest known scientific study of this was made by the engineers who accompanied Napoleon to Egypt. They estimated, from the depth to which antiquities were buried, that the average rate of silt deposit amounted to about 10 cm. per century. More recent estimates[1] have confirmed this figure, and to-day it is generally accepted that the mean rate of deposition is about 9 cm. per century.

The presence of silt in the Nile water, however, besides entailing every year a heavy expenditure for its removal from canals,[2] has also the disadvantage of limiting the time during which storage reservoirs on the Blue and Main Niles can be filled. The rule in the past—to avoid any risk of silting up the Aswan reservoir—was to start filling after the peak of the flood had passed and the gauge downstream had fallen to 88·00, when the quantity of silt in the water would have decreased considerably.

But with the increase in capacity of the reservoir due to the two heightenings of the Aswan dam, the date at which filling commences has been advanced, and is now usually about the middle of October, when the Aswan gauge falls to 91·00. This date will have to be still further advanced if the storage level is raised to R.L. 122·00 to meet the programme of near future development. Filling in low years will even have to start at the crest of the flood.

Again, until adequate measures for flood protection, such as the heightening and consolidation of the Nile banks or the provision and operation of flood escapes, have been undertaken, the menace of a very high flood might be averted by the use of the Aswan reservoir as an emergency flood escape.[3] The reservoir is empty in flood, and it can take, if filled to R.L. 110, about 80 millions of cubic metres per day for about twelve days. This would mean a reduction of about 0·5 m. at the Roda gauge.

Thus each of these two functions of the reservoir—the conservation of larger amounts of water to meet the expansion in cultivation and flood control—involves the retention in the reservoir of some of the silt-laden flood waters.

Hence the important question arises, How much silt would be deposited by storing flood water in the Aswan reservoir ? This question is of vital interest to Egypt, for if it should prove that water could safely be impounded in flood without any serious diminution of reservoir capacity, the whole scheme of future projects would have to be revised.

In order to be able to answer this question, definite experimental evidence should be obtained.

Careful determinations of the quantity of silt in suspension in the Nile were carried out by the Physical Department in 1929, 1930, 1931, 1935, and 1938, and mechanical analyses to determine the quality of the silt were made in 1929, 1930, and 1931.

In 1929, 1935, and 1938 the reservoir was partly filled at the top of the flood, up to R.L. 101, 104·80, and 107·13 respectively, and silt concentrations were measured at Halfa and Gaafra.[4]

The present paper gives a description of the methods used, the results obtained and some tentative conclusions to be drawn from these results. It also sets forth the lines on which investigations should be directed in the future for a comprehensive study of the silt problem.

It should be here mentioned that the technique of the collection of samples and the determination of silt concentration, as well as the design of the mechanical analyser, are due to the late Dr. Percy Phillips, while the classification of the suspended solids is based on the principles laid down by the International Congress of Soil Science, held in Washington in 1927.

Conclusion and Proposals for Further Investigations.—The results here under consideration are based on investigations made on the solid matter carried along by the Nile in actual suspension in its waters, taking no account of the bed load, *i.e.*, the sand, silt, &c., that is swept along the river bed by the motion of the stream.

In finding the silt concentration, care was taken to avoid collecting the lowest sample too near the bed, for fear that the sampling apparatus might stir up the bed itself to an extent which might vitiate the results.

On the other hand, if the larger part of silt in the river were in the form of liquid mud moving along the bed, there might be the possibility that the sample nearest the bottom would not be sufficiently low to catch the moving mud and the concentration as determined would not be the true concentration of the stream.

Little information is available as to the quantity of material transported in streams as bed load, and in spite of many attempts, especially in the United States, no successful method has yet been devised for measuring its amount. However, in the Nile, if the bed load were considerable, one would expect a continual rise of the bed on the upstream side of the solid part of the Aswan dam, for which there is no evidence, unless the conditions are such that the bed load is carried through the sluices. Until more light is thrown on this question, a great deal of uncertainty must necessarily remain as to the estimates based on suspended matter only.

The question of silt deposition in the Aswan reservoir is extremely important, and a definite answer cannot be given at this stage, since data concerning the ratio of the bed load to the load carried in suspension are not available. Under these circumstances, and in view of the magnitude of the interests involved, it is suggested that an absolute method of measurement of the silt deposition should be applied. In other words, it is imperative to make a careful capacity survey of the reservoir for comparison with previous and future surveys. Simultaneously with this survey it is suggested that the silt experiments should be repeated, for, from a comparison of the volume of the total deposit in the reservoir—as obtained from the capacity survey—with the volume of the silt deposited from suspension, as obtained from the silt-sampling experiments, the percentage of the bed load to the load carried in suspension can be determined. A knowledge of this percentage would be useful in roughly estimating the deposits due to the bed load in the experiments of 1929, 1930, 1931, and 1938, and thus completing their results.

To sum up, we enumerate as follows our suggestions as to possible means for supplementing the previous silt experiments and making absolute measurements of the actual deposits in the reservoir :—

(A) I. Repetition of the silt experiments at

* Abstracted from a report under this title regarding investigations relating to the Aswan reservoir by Y. M. Simaika. The report itself, recently issued by the Ministry of Public Works, Egypt, contains detailed particulars of the experimental work.

[1] "Contributions to the Geography of Egypt," by John Ball, Cairo, 1939, page 176.

[2] In the financial year 1937–38 the expenditure for the removal of silt from canals and drains amounted to about £E272,000.

[3] In the flood of 1938 the reservoir was used as a flood escape. The Aswan D.S. gauge was not allowed to rise above 93·32, the extra flow being held up in the reservoir. This raised the reservoir level to a maximum of 107·13 on September 19th. The reduction at the top of the flood at Aswan was about 20 cm., corresponding to about 30 cm. on the Roda gauge during the second week of September (Cairo date), and the amount impounded in the reservoir was about 470 millions of cubic metres. This has been determined by comparison of the actual discharges upstream and downstream of the reservoir in the period, with due allowance for lag and losses. The tables of reservoir content (which are based on the assumption of a horizontal reservoir) could not be used at this stage, owing to the backwater effect.

[4] In 1938 silt concentration was also measured at Dakka, 105 kilom. upstream of the dam and at Aswan, 10 kilom. downstream of the dam.

Halfa, Aswan, and Gaafra (discharges of the river to be taken at Halfa and Gaafra).

II. Mechanical analysis of (*a*) silt in suspension (*b*) silt from deposits, and (*c*) silt from the bed of the river.

(B) I. Taking about 200 cross sections[5] right across both banks and the bed of the reservoir at accurately marked positions, say, every kilometre for the first 100 kiloms. from the dam and then every 2·5 kiloms. up to Halfa, with additional cross sections at suitable points across the important Khors. The cross sections should be taken when the reservoir level is steady or changing slowly.

II. Fixing precise bench marks[6] on each bank at each of the cross sections.

III. Erecting gauges along the reservoir at places where they could be read regularly.

IV. Making a hydrographic survey of the reservoir at, say, ten blocks, each about 1 kilom. in length, one block to be just upstream of the dam and the others within the first 100 kilom. from the dam.

The corner points of each block should be fixed by concrete pillars similar to those used for first order triangulation.

V. Making a topographic survey of the reservoir by means of the "British Admiralty recording water echo sounder," which is being extensively used in many harbours.

The possibility of carrying out these suggestions and the accuracy of the results likely to be obtained are at present under investigation.

The subject of silt is one of considerable importance to Egypt and deserves further study. In this paper only silt in the river has been considered, but its behaviour when it enters the large canals and smaller distributaries is also important. There is room therefore for a good deal of research, some of which has been suggested.

It is hoped that it will be possible to carry out some of this work in the near future, and in particular to determine the limits within which it is safe to regulate the Aswan reservoir during flood.

New U.S. Navy Ordnance Plant

THE award of the general contract to construct four major buildings of a new Navy ordnance plant near Louisville, Ky., is announced by the Westinghouse Electric and Manufacturing Company, of East Pittsburg. The company has been selected by the Navy to build and operate the plant under a leasing arrangement. Grading and foundation work at the site will start within a few weeks, and the completion of the buildings is scheduled for July. The general contract for the manufacturing buildings, the heating plant, and the service building has been let by the Westinghouse Company to the J. G. White Engineering Corporation, of New York.

The new plant will employ about 1000 skilled workers, and will operate principally as an assembly unit, receiving parts from other ordnance plants and manufacturers. Upon completion, guns and mounts will be proof-fired on an adjacent proving ground and later will be shipped to naval vessels for installation. As announced by the Navy Department, the list of products for the Louisville plant will include mounts, turret items, gun slides, recoil mechanisms, breech housings, and breech blocks. Many of the parts received at the Louisville plant will be manufactured at an ordnance plant which the Westinghouse Company will construct and operate for the Navy at Canton, Ohio. Preliminary work has been started on the site. The Canton works will include about the same number and types of buildings as the Louisville plant, but will use considerably more machine tools and employ approximately 2000 skilled workers, since it is designed principally for machining naval ordnance equipment.

The Westinghouse Company has already assigned thirty of its principal factory supervisors to the task of preparing for the construction and equipping of the Louisville and Canton plants. This management staff is now at work, selecting machine tools and other equipment and developing manufacturing operation lay-outs. Work on jigs and fixtures is under way, and orders for about 6,250,000 dollars' worth of machine tools and equipment for the two plants have been let. During the next few months orders for another five or six million dollars' worth of machine tools will be let.

MANAGING A RESEARCH LABORATORY.—The New York University College of Engineering is arranging to hold its first organised course in research laboratory management. It has been planned by an advisory committee headed by Mr. M. Holland, Director, Division of Engineering and Industrial Research, National Research Council.

[5] These cross sections will serve a double purpose. For, if as part of the routine of the working of the reservoir, they are measured at regular intervals, say, every five years, then changes, if any, which occur in the bed due to the early filling of the reservoir will be detected and the tables of the reservoir content could be corrected, if necessary.

[6] The establishing of the bench marks should be entrusted to the Survey Department.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Our Export Trade

The Institute of Export has published under the heading "The Case for Export" a "Survey of Difficulties and Recommendations for Improvement." The survey was undertaken by Mr. J. Morris and is of considerable interest to firms engaged in the export trade. In the Introduction it is pointed out that two potent factors surround the survey in all its angles and applications. They are the present world conditions and the multiplicity and scope of the export trade. Due largely to the war, it is suggested that the immediate problem is the relationship of Government to business, and this aspect of the subject is dealt with in a practical manner. With regard to Licensing Departments, which have an enormous power and influence upon British trade to-day, the survey suggests that "it is admittedly impossible to export any commodity essential for war needs, and thus a large percentage of characteristic British manufactures falls under this ban. It is therefore beyond question that all non-essential products which have or can attract suitable markets abroad should be permitted to be manufactured freely and sold freely." It was found that manufacturers generally showed willingness to co-operate in the development of export trade, but that the ability of manufacturers to quote firm prices is dependent upon so many factors over which outside control is exercised that only the improvement of these controls could alter the position. The survey also suggests co-operation between manufacturers making similar products to arrive at agreement to manufacture a standard British article for export, whilst a unified production plan between such manufacturers would be of inestimable value now and for future export development. There is some criticism of manufacturers and also of the kind of assistance rendered by Government Departments. Commenting upon the United Kingdom Commercial Corporation, the survey says that "in the interests of private traders it is advisable to note that if the Corporation continues to operate further afield than at present in post-war years, it can only do so at their expense because they have failed to take care of the volume of export trade this country must have." One of the most important suggestions made in the survey is that a Ministry of Overseas Trade should be formed to incorporate sections dealing with import trade and export trade, and to take over from all other Ministries all Departments dealing with either of these sections.

The Pig Iron Market

Practically every available blast-furnace in the country is now in operation and production has reached a high level. The organisation of the pig iron industry for the war effort is standing the test of present conditions well, and under the careful supervision of the Control distribution is generally regarded as satisfactory, although there have been some delays in transit which, however, have not been serious. On the North-East Coast practically the whole of the pig iron producing plant is turning out basic iron for the steel works, and foundries are obtaining their supplies from the Midlands. Occasional parcels of Cleveland foundry iron are available, and these are quickly taken up as the make of this quality is insignificant. Midland foundry iron is also going to Scotland to meet the requirements of consumers there who formerly used Cleveland. Transport arrangements, however, leave consumers little to complain of, and in spite of the longer rail haul they do not have to pay more for their iron. Scottish consumers, in fact, get their supplies from the Midlands at 1s. 3d. per ton less than the official price of Cleveland No. 3. The light castings industry, which is the largest user of high-phosphoric iron, is not fully employed, although it is operating at a more active rate than some weeks ago. This industry finds no difficulty in satisfying all its pig iron requirements, and it is understood that the makers have good reserves of this iron in hand. The Control is also taking a more lenient view of the position and has permitted consumers to build up small stocks for use in an emergency. There has been no slackening in the demand for low-phosphoric pig iron. The supplies of hematite are rather tight, but it is understood that the Control has a good reserve of imported hematite to fall back upon. Large tonnages are passing into consumption to the heavy engineering industry, practically the whole of which is employed upon war work. In Scotland there is a steady movement of pig iron from the blast-furnaces directly it is produced, and consumers of hematite are also pressing for supplies. The light castings industry in Scotland is irregularly employed.

Scotland and the North

The majority of the Scottish iron and steel works have been producing at capacity for a long time, and naturally this has put a strain upon plant. Outputs, however, are proceeding at a high level and the makers are able to maintain this great activity owing to the adequate supplies of raw materials which are available. The steel makers would like to see an increase in scrap supplies, but fresh arrivals are expected which should make the position satisfactory. The pressure from the shipyards to obtain steel seems to be increasing rather than the reverse, and it is particularly strong in the case of ship plates. The works producing this material have had to meet an exceptionally heavy demand for several weeks, and in view of the big shipbuilding programme in hand there is not likely to be any early slackening in the pressure from this industry. The stringency in the plate department, however, does not appear to be quite so noticeable as a few weeks ago, although the position remains somewhat tight. The sheet makers, also, are experiencing a strong demand, but with ample supplies of semis available they are able to attain a good rate of production. The demand for sheets, however, is growing, and consumers who are not engaged upon Government work are finding it difficult to obtain supplies. Practically all the consuming industries in Lancashire are engaged upon war work and their requirements of steel are on a heavy scale. The demand for bars, which has been a feature of the market for some time, has eased to some extent, and small bars appear to be in better supply. The larger sizes, however, are still not easily obtainable for near delivery. The demand for structural steel seems to have fluctuated somewhat of late, and at the moment is only moderate; but the stockholders are apparently doing a good business in this class of steel. The locomotive engineers, boilermakers, and tank makers, who have big order books, are in the market for heavy plates, but most of the producing works ask rather long periods for delivery.

Copper and Tin

The situation in the copper market has not greatly changed either in Great Britain or the United States. Here, the Control continues to keep the war industries well supplied, and a certain amount of metal is also available for firms employed upon making exportable products. Judging from appearances, whilst the situation can be described as comfortable, there would not seem to be any great surplus, so that firms engaged upon neither export nor war work do not at times find it easy to get their full requirements. In the United States the market remains steady. The domestic price is retained at 12c. d/d, but for export the price is a shade less firm at 10·37½c. f.a.s. Consumers in the United States are taking up good quantities, although the demand has not reached the excessive proportions which it was anticipated in some quarters would develop in the early spring. Little export business has been transacted, although it is understood there have been inquiries both from Russia and Japan. Domestic requirements, however, are sufficiently large to keep the authorities on the alert to see that too much copper is not sold overseas. Export transactions are, of course, subject to licence, but it is understood that these are forthcoming for Great Britain and the Dominions. It is anticipated in some quarters that the United States authorities will make fresh purchases of South American copper in addition to the recent purchase of 200,000 tons of Chilean metal. . . . The tin market has receded from the high levels reached under the impetus of American buying, and some speculation on this side. This was not altogether unexpected, since there was no really sound basis for the sharp advance of last week. The rather better international outlook in the Far East no doubt had much to do with this movement, as its development was followed by the practical cessation of American buying and a certain amount of profit taking on the London market. More nearby tin also became available and the backwardation rapidly dwindled as a result.

Lead and Spelter

The big demand for lead in Great Britain continues unchecked, the principal users being the cable makers and the battery makers. In spite of the large quantities passing into consumption, the British lead situation is considered satisfactory, and supplies seem to be reaching this country with regularity and in considerable tonnages. There is more variation in the position of the consuming trades, and whilst those engaged upon war work remain actively employed, the pipe and sheet makers are feeling the effects of the practical cessation of building. Export business in lead products has not been active and recently British export quotations were advanced by £1. In the United States the demand is steady and good quantities are passing into consumption; but there has not been the rush of orders to the producers which was at one time prophesied would result from the American rearmament programme. The quotation has advanced to 5·75c. New York. The stocks in the United States are not heavy, and at the end of January totalled 47,200 tons, compared with 40,900 tons at the end of December. The January production was 62,000 tons, compared with 61,800 tons in the previous month, whilst the deliveries totalled 55,700 tons against 56,800 tons in December. . . . The spelter situation remains unaltered. In most of the world markets the position is tight, but in Great Britain the Control appears to have had no difficulty in keeping the war industries fully supplied with the metal required. Stringent conditions rule in the United States market, and it is significant that reports are heard that it is exceedingly difficult to get export licences for this metal. Apparently the American authorities are of the opinion that the surplus after the home industries are satisfied should be conserved in case the position should deteriorate. It is suggested that for some countries requiring brass products from the United States the materials are manufactured from metal in bond. It is understood that the authorities have asked the American spelter producers not to sell metal on the Commodity Exchange, but to reserve it for direct sales to consumers.

Non-ferrous Metal Prices

The London Metal Exchange official statement for February shows a considerable rise in the average quotations for tin during that month, which may be attributed to the tension which developed in the East. The average price for cash tin rose by £8 8s., and for three months by £5 4s. 9d. above that for January, the settlement price being £8 7s. 7d. higher. The statement, which includes the official maximum prices for copper, lead, and spelter, is as follows :—

		£	s.	d.
Standard tin	Cash (mean)	£265	3	10½
	Three Months (mean)	£263	19	7½
	Settlement	£265	2	9

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-Ferrous Metals :—

	£	s.	d.	
Standard copper	—			
Electrolytic copper	62	0	0	delivered buyers' premises
Electrolytic wire bars	62	0	0	" " "
Best selected copper	60	10	0	" " "
Lead, good soft pig (foreign)	25	0	0	" " " (duty paid)
Spelter, G.O.B. (foreign)	25	15	0	delivered buyers' premises (duty paid)

Notes and Memoranda

Rail and Road

MOBILE GAS UNITS.—The Board of Trade has made an Order which comes into force at once prohibiting the export to any destination, except under licence, of mobile producer gas units.

TO LINK HUNGARY WITH RUSSIA.—Negotiations are afoot for a railway between Hungary and the U.S.S.R., with a junction between the two railways at Munkacs. Hungary and the U.S.S.R. have had a common frontier since the occupation of Poland.

RAILWAY TELEPHONES.—The number of telephone inquiries put through by the public last year and handled by the staff at Paddington Station exceeded a million and a quarter, more than three-quarters of a million above the figures for 1938, the last complete peace year.

ELECTRIFICATION IN BRAZIL.—The conversion of the second section of the Central Railway of Brazil to electric traction has begun, and in recent months it has been decided to carry the work further along the line than was originally contemplated. The additions will include the electrification of the branch line from Deodoro to Santa Cruz. The reason for this extension is the establishment at Volte Redonde of the Brazilian Steel Company's new works.

PRODUCER GAS.—In a speech made in London recently, Mr. John F. Heaton, chairman and managing director of Thomas Tilling, Ltd., reported that the purely scientific side of producer gas problems was being dealt with on the company's behalf at the Mining Department of the Birmingham University under the general direction of Professor Neville Moss and Dr. S. Ward. There had been a good deal of uninformed criticism of producer gas operations, but so far as Tilling's were concerned they were satisfied with the progress which was being made.

FROM RAIL TO ROAD.—America from time to time converts its railway track into highways, and a recent example of this practice is the transformation of the Profile Railroad formation, in New Hampshire, into a highway. Originally built as a narrow-gauge line in 1878, the Profile Railroad connected the Boston and Maine Railroad with Profile House, near Echo Lake, and was about 9 miles in length. It was for a time an attraction to the tourist, and the railway did good business. Sustaining losses by fire in 1915 and again in 1923, the railway was closed and the permanent way removed.

TRAM *v.* MOTORBUS.—Originally laid down in 1885, a cable tramway system has served Melbourne for more than fifty years. According to the latest report of the Melbourne and Metropolitan Tramways Board, the conversion to motorbus operation of the final section of the cable tramway system was to have taken place in March of last year. In order to co-operate with the Government in the conservation of fuel oil, however, it was decided to defer the change over until the cables were no longer usable. The last cable routes, 7·8 route miles in length, were actually replaced by motorbuses last October.

Air and Water

OIL CRACKING.—The Standard Oil Company of New Jersey is reported to have perfected a fluid-catalyst process for the cracking of petroleum which simplifies production, lowers operating costs, and improves the quality of the petrol obtained. The company has started the construction of three large plants to work the process, and another company is building a plant under licence.

OIL IN MONGOLIA.—The Engineering Department of Kyoto Imperial University is to start drip drilling for oil at Dzalainoerh in Inner Mongolia, where the prospects are regarded as better than those at Fuhsin, Jehol Province, Manchoukuo. Meanwhile, reports are coming through that considerable oil is being taken from the No. 1 Fuhsin well daily and that engineers from Hsinking are working on the Fuhsin No. 2 well.

ARGENTINA TAKES OVER A PORT.—A decree has been issued by the Government to take over the Rosario port works as from October, 1942, when the concession of the company at present operating the port expires. The concern was originally financed by French capital, the profits being divided between the company and the Government; but the terms of the concession have often led to litigation, in which the Government has generally been the loser.

A BOMBAY-BUILT MOTOR LAUNCH.—A new motor launch which was built at Bombay is to be placed in service between Bankot, some 150 miles south of Bombay, and Bankot Creek, a distance of about 30 miles. The launch will be employed on passenger service. Its principal dimensions are: Overall length, 45ft.; beam, 12ft., and draught, 2ft. 6in. It is propelled by a four-cylinder Ruston engine having a designed output of 40 B.H.P. During the official trials a speed of between 8 and 8½ knots was recorded.

HOW MUCH MOISTURE ?—An American firm has introduced a battery-operated detector which determines the degree of moisture content in wood, plaster, textiles, and other materials by taking advantage of the fact that the electrical resistance of many materials is a function of the moisture content. With the development of vacuum-tube circuits it has been possible to apply this method in measuring electrical resistance and, therefore, the amount of moisture present. No skill is required in using the device, which weighs only 7 lb.

A TWO-MILE ROAD BRIDGE.—There has recently been opened in America a roadway bridge 2 miles long over the Potomac, between Morgantown, Md., and Dahlgren, Va. An 800ft. cantilever structure spans the main channel, for which the foundations are caissons filled with concrete after being sunk to river bed level to rest on steel H piles driven to rock. Some piers are as much as 96ft. high, and for the approach work the piling is as long as 194ft. The world's largest floating pile driver was assembled to drive this record length. The roadway is 24ft. wide with 1½ft. walks on each side. The State of Maryland will operate the structure as a toll bridge.

AMERICAN SHIPBUILDING.—Two Army transports, two 35,000-ton passenger ships and five gasoline tankers will be ordered in 1941 by the Maritime Commission, U.S.A. The 35,000-ton passenger vessels will have funnels on the starboard side for quick conversion into aircraft carriers. They will be 759ft. long and the speed will be over 24 knots. During 1940 the ships built or building under some phase of the Commission's programme reached 179 at a contract price of over 450,000,000 dollars. Of this number, ninety-one have been launched, sixty-one delivered and twenty-four have been acquired by the Navy. Deliveries are now at the rate of one a week.

Miscellanea

MICA COMMANDEERED.—The Commonwealth Government of Australia has commandeered all mica in the Northern Territory, the only part of Australia in which this mineral is produced in commercial quantities.

ITALIAN POTASH.—The S. A. Italiana Potassa, after reducing its capital, has amalgamated with the "Vulcania" concern, which has hitherto been solely engaged in the exploitation of volcanic minerals for industrial purposes.

COPPER SULPHATE IN THE DUTCH EAST INDIES.—The manufacture of copper sulphate for the first time in the Netherlands Indies has been commenced by the N.V. Chemische Industrie en Handel Mij., at its works at Sopanjang, near Sourabaya.

RED SEA TIN.—Large tin deposits, estimated by Egyptian experts at 500,000 tons, have been discovered in the neighbourhood of Kosseir, on the Red Sea coast. After four months' prospecting by a private concern these deposits were found in the Wadi el Agala, and the veins, which are rich in tin, cover an area of several miles. It is hoped that these Egyptian mines would produce about 15,000 tons of pure tin annually.

STANDARDS IN CANADA.—Working in conjunction with the Canadian Institute of Steel Construction, the Federal Steel Controller, H. D. Scully, has decided upon a standardisation of Canadian-rolled beams, channels and angles to be used by the structural steel industry for the duration of the war. The aim of this standardisation is to speed up Canadian mill deliveries of materials required in the fabrication of structural steel.

THE ALSATIAN POTASH MINES.—The German Reich has now taken over the Alsatian potash mines, and will administer them temporarily through a commissary. The re-possession of the mines is likely to be followed by their transfer to their former German owners, who received only a nominal indemnity from the Reich (about 15 per cent. of the officially appraised price), when the mines were turned over to the French State under the Versailles Treaty.

THE UTILISATION OF LIGNITE.—The A.G. für Kraftstoff-Anlagen has been founded in Dresden with a basic capital of 150 million R.M. to finance, construct and lease plants for the production of electrical power and distillation products from lignite. The corporation will construct its refineries and power plants in proximity to the lignite fields of the A.G. Sachsische Werke, and the plants will be rented under a long-term contract to the latter-mentioned company.

GLASS BELLS.—In order to save metal German engineers are replacing metal telephone bells with bells made of glass and metal composition. Glass-lead compositions were first devised for the manufacture of telephone and similar bells, but as lead is one of Germany's important import raw materials, other experiments were made and led to the discovery of a glass composition consisting entirely of domestic raw materials that fulfils all requirements for bells.

THE TEST HOUSE AT MANCHESTER.—The Manchester Chamber of Commerce Testing House reports a record, despite the destruction of its laboratories in the Royal Exchange buildings by fire caused by enemy action. Fortunately, since the beginning of the war alternative premises had been in occupation outside the city. It had also been possible to salvage a number of machines and instruments from the Manchester laboratories. During the year 67,819 samples were tested.

THE LATE MR. W. H. NOCK.—We regret to learn of the death on February 24th at Borth, Wales, of Mr. William Henry Nock at the age of seventy-five. For the past twenty-nine years and right up to the time of his death Mr. Nock had been on the board of directors of the Wellington Tube Works, Ltd., Tipton, and on the board of directors of its associated companies, the Victoria Tube Company, Ltd., and Edward Smith, Ltd. Mr. Nock's services to the Wellington company were continuous for over sixty years.

Personal and Business

MR. CHARLES H. LUKE, F.R.S.A., has been elected a director of the Superheater Company, Ltd.

MR. M. ARNET ROBINSON has been elected to the Mersey Docks and Harbours Board in succession to the late Mr. M. H. Hulme.

MR. C. E. VERITY, technical engineer to the London Power Company, Ltd., has taken up temporary special duty for the Air Ministry.

THE EXPORT CREDITS GUARANTEE DEPARTMENT announces that the London and Southern District office has been transferred to Third Floor, North-West Wing, Bush House, Aldwych, London, W.C.2. Telephone number, Temple Bar 7622; telegraphic address, "Credexport Bush London." A branch office will be maintained at the Department's headquarters, 9, Clements Lane, Lombard Street, London, E.C.4.

SIR JOHN IRVIN, K.B.E., has been elected President of the Dock and Harbour Authorities' Association in succession to Lord Ritchie of Dundee.

THE GREAT WESTERN RAILWAY announces that Mr. H. J. Peacock, Divisional Superintendent, has been appointed Assistant Superintendent of the Line, stationed at Cardiff.

MR. E. E. HOADLEY and Mr. R. Birt have been appointed by the Incorporated Municipal Electrical Association to serve on the Joint Committee of Electricity Supply Associations.

MR. B. H. COLQUHOUN has been released by Sir Alexander Gibb and Partners to take up the appointment of Director-General of Aircraft Production Factories in the Ministry of Aircraft Production.

MR. H. MUSCROFT, General Manager and Engineer of the Southend-on-Sea Corporation Passenger Transport Department, has been appointed General Manager and Engineer of the Huddersfield Corporation undertaking.

MR. H. E. HARRIS, M.I. Mech. E., M. Inst. Met., M.I. and S.I., has joined the board of directors of J. Hibbert and Co., Ltd., of Darwen, Lancashire. Mr. Harris is already a director of Platt Brothers and Co., Ltd., and Asa Lees and Co., Ltd., both of Oldham.

THE BRITISH ALUMINIUM COMPANY, Ltd., temporary head office, Oakley Manor, Belle Vue, Shrewsbury, Shropshire, announces that its Birmingham office has been removed from Lawley Street to Lansdowne House, 41, Water Street, Birmingham, 3; that the Bristol office and warehouse are closed temporarily, and that the London office has been removed from Norfolk House to Trafalgar House, Waterloo Place, London, S.W.1.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, March 10th.—Technical College, Bradford. "The Hydraulic Operation of Machine Tools," H. C. Town. 7.15 p.m.

Chemical Engineering Group

Tuesday, March 11th.—Chemical Society's Rooms, Burlington House, Piccadilly, W.1. "Ventilation (Natural and Artificial) in relation to the Black-out," E. W. Murray. 2.30 p.m.

Illuminating Engineering Society

Tuesday, March 11th.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2. "Recent Work on A.R.P. Lighting Problems." 2.30 p.m.

Institute of Marine Engineers

Friday, March 14th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Annual general meeting. 12 noon. Luncheon, 1 for 1.15 p.m.

Institute of Transport

Saturday, March 8th.—METROPOLITAN GRADUATES: Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "A Brief Survey of the Creation and Evolution of Occupations and a Consideration of Transport as a Profession," C. F. King. 2.15 p.m.

Monday, March 10th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "The Road and Rail Transport Problem," Brigadier-General Sir H. Osborne Mance. 4.50 p.m.

Institution of Automobile Engineers

Saturday, March 8th.—N.W. CENTRE: Engineers' Club, Albert Square, Manchester. "Some Notes on an Extended Test of Creosote Mixture in C.I. Engines." W. Allen. 3 p.m.

Institution of Electrical Engineers

Tuesday, March 11th.—SCOTTISH CENTRE: Royal Technical College, Glasgow. "The Glasgow Automatic Telephone System." Major H. A. Ashdowne. 6.15 p.m.

Wednesday, March 12th.—N.E. CENTRE: Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne. "Electric Traction," C. E. Fairburn. 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, March 11th.—39, Elmbank Crescent, Glasgow, C.2. "Wartime Building," R. Fitzmaurice. 6.30 p.m.

Junior Institution of Engineers

Saturday March 8th.—39, Victoria Street, Westminster, S.W.1. "Notes from an Engineer's Scrap-book" R. H. Squire. 2 p.m. MIDLAND SECTION: James Watt Inst., Birmingham. "Some Problems of Electricity Distribution," D. Birch. 3 p.m.

Saturday, March 22nd.—39, Victoria Street, Westminster, S.W.1. "The Chemist, the Chemical Engineer, and the Mechanical Engineer," P. A. Cartwright. 2 p.m.

North of England Institute of Mining and Mechanical Engineers

Saturday, March 8th.—ASSOCIATES' AND STUDENTS' SECTION: Neville Hall, Newcastle-upon-Tyne. "Problems of Ventilation with reference to Development," W. S. Foster, and "The Coal Dust Problem," L. Walker. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Wednesday, March 12th.—STUDENT SECTION: Bolbec Hall, Newcastle-upon-Tyne. "Propeller Design," E. Panagopoulos. 6.45 p.m.

Friday, March 14th.—Mining Inst., Newcastle-upon-Tyne. "Some General Observations on Vibration," J. Calderwood. 6 p.m.

Royal Institution of Great Britain

Tuesday, March 25th.—21, Albemarle Street, London, W.1. "The Physical Condition of the Planets," Sir James Jeans. 2.30 p.m.

Royal Society of Arts

Wednesday, March 12th.—John Adam Street, Adelphi, W.C.2. "Replanning London," W. H. Ansell. 1.45 p.m.

Sheffield Metallurgical Association

Saturday, March 15th.—198, West Street, Sheffield. "Modern Methods of Metallurgical Analysis," E. J. Vaughan. 3 p.m.